Ministry of
Northern Development
and Mines
Ontario

Mines and
Minerals
Division

Geology of the

Dalhousie Lake Area

Frontenac and Lanark Counties

Ontario Geological Survey
Report 245

by Liba Pauk

This project was part of the Southeastern Ontario Geological Survey (SOGS) which was funded equally by the Federal Department of Regional Economic Expansion (DREE) and the Ontario Ministry of Natural Resources under the Minerals Program of the Eastern Ontario Subsidiary Agreement.

1989

90-02507/

©Queen's Printer for Ontario, 1989
ISSN 0704-2582
Printed in Ontario, Canada
ISBN 0-7729-1037-5

Publications of the Ontario Geological Survey, Ministry of Northern Development and Mines, are available from the following sources. Orders for publications should be accompanied by cheque or money order payable to the *Treasurer of Ontario*.

Reports, maps, and price lists (personal shopping or mail order):

Public Information Centre, Ministry of Natural Resources
Room 1640, Whitney Block, Queen's Park
Toronto, Ontario M7A 1W3

Reports and accompanying maps only (personal shopping):

Ontario Government Bookstore
Main Floor, 880 Bay Street
Toronto, Ontario M7A 1N8

Reports and accompanying maps (mail order or telephone orders):

Publications Services Section, Ministry of Government Services
5th Floor, 880 Bay Street
Toronto, Ontario M7A 1N8
Telephone (local calls) 965-6015
Toll-free long distance 1-800-268-7540
Toll-free from Area Code 807 0-ZENITH-67200

Canadian Cataloguing in Publication Data

Pauk, L. (Liba)

Geology of the Dalhousie Lake area, Frontenac and Lanark Counties

(Ontario Geological Survey report, ISSN 0704-2582 ;
245)

Spine title: Dalhousie Lake area.

ISBN 0-7729-1037-5

1. Geology--Ontario--Dalhousie Lake Region. I. Ontario. Ministry of Northern Development and Mines. II. Ontario Geological Survey. III. Title. IV. Title: Dalhousie Lake area. V. Series.

QE191.P28 1989 557.13'71 C86-099622-0

Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Northern Development and Mines does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

Parts of this publication may be quoted if credit is given. It is recommended that reference be made in the following form:

Pauk, Liba
1989 Geology of the Dalhousie Lake Area, Frontenac and Lanark Counties; Ontario Geological Survey Report 245, 57p. Accompanied by Map 2512, scale 1:31 680.

If you wish to reproduce any of the text, tables or illustrations in this report, please write for permission to the Director, Ontario Geological Survey, Ministry of Northern Development and Mines, 11th floor, 77 Grenville Street, Toronto, Ontario, M7A 1W4.

Critical Reader: B.O. Dressler
Scientific Editor: E.F. Moorhouse

1000-89-Lowe-Martin

Foreword

The Dalhousie Lake area bedrock contains occurrences of copper, iron, molybdenum, uranium, and thorium. Nonmetallic deposits present in the area consist of calcite, quartz, feldspar, tremolite, and talc.

The primary aim of the detailed mapping of Dalhousie Lake area is to provide an effective basis for determining the mineral and land use potential of the area and to encourage mineral exploration. The study will also provide geological information that together with future detailed projects will lead to a regional geological synthesis and to a better understanding of the mineralization environments in southeastern Ontario.

V.G. Milne

Director

Ontario Geological Survey

Contents

Abstract 1
Résumé 2
Introduction 3
Area, Location, Means of Access 3
Present Geological Investigations 3
Acknowledgments 3
Previous Geological Work and Prospecting Activity 4
History of Mineral Exploration 4
Physiography 5
General Geology 6
Table of Lithologic Units 7
Late Precambrian 10
Metavolcanics and Metasediments 10
Metavolcanics 10
Mafic to Intermediate Metavolcanics 10
Metasediments 11
Clastic Metasediments 11
Siliceous Clastic Metasediments 11
Calcareous Clastic Metasediments 12
Interlayered Gneissic Metasediments and Metavolcanics 13
Carbonate Metasediments 14
Early Intrusive Rocks 15
Early Tectonic to Syntectonic Metamorphosed Felsic Intrusive Rocks 16
Northbrook Batholith 16
Addington Complex 16
Early Tectonic to Syntectonic Mafic and Intermediate Intrusive Rocks 17
Dalhousie Amphibolite Complex 17
Lavant Gabbro Complex 17
Flinton Group 23
Bishop Corners Formation 23
Late Intrusive Rocks 24
Late Tectonic Felsic Intrusive Rocks 24
Elphin Intrusion 24
Barbers Lake Intrusion 25
Pegmatite Dikes and Sills 25
Phanerozoic 27
Cenozoic 27
Quaternary 27
Pleistocene and Recent 27
Metamorphism 28
Western Structural Zone 28
Eastern Structural Zone 28
Structural Geology 30
Regional Setting 30
Folds 30
Western Structural Zone 30
Eastern Structural Zone 32
Faults 33
Stratigraphic Interpretation 34
Correlation of Geology and Geophysics 35
Economic Geology 36
Metallic Mineralization 36
Copper 36
Copper and Gold in Quartz Veins 36
Disseminated Chalcopyrite in Carbonate Rocks 36
Iron Oxides 36
Molybdenum 37

Sulphide Mineralization 37
Uranium and Thorium 37
Nonmetallic Mineralization 40
Calcite 40
Marble 40
Quartz and Feldspar 40
Tremolite-Talc 40
Sand and Gravel 41
Description of Properties 41
Copper and Gold 41
Corval Corporation Ltd. [1958] (3) 41
Picamine Copper Gold Mines Ltd. (7) 41
Iron Oxides 42
Robertsville (Mississippi) Mines Ltd. [1951] (11) 42
Uranium and Thorium 44
AJM Explorations Ltd. (1) 44
Consolidated Imperial Resources Ltd. (2) 45
Emmery, V. Occurrence (4) 47
Groundstar Resources Ltd. (5) 47
Ram Petroleums and Taman Resources Ltd. (9) 47
Riddell, D.W. (10) 48
Calcite 48
Marlhill Mines Ltd. (6) 48
Tremolite-Talc 48
Ram Petroleums Ltd. (8) 48
Tremolite Zones 49
Main Zone 49
Southwest Zone 49
Far South Zone 49
Suggestions for Future Mineral Exploration 51
References 52
Index 55

TABLES

1. Table of Lithologic Units 7
2. Metamorphic mineral assemblages in the supracrustal rocks of the Western Structural Zone 29
3. Inferred age relationship between lithologic units 34
4. Properties and occurrences 38
5. Exploration programs of AJM Explorations Ltd. Property 46
6. Analysis of fine flaky fibrous mineral, Palmerston Township 49
7. Estimated ore reserves, Ram Petroleums Ltd. 50

FIGURES

1. Key map showing location of the Dalnousie Lake Area 3
2. Robertsville magnetite deposit 43

PHOTOGRAPHS

1. Marble with lenses and layers of quartzite with boudins 15
2. Coarse-grained ophitic texture, Dalhousie Amphibolite Complex 19
3. Metaconglomerate of the Flinton Group 24
4. Isoclines in metasediments in Cross Lake Antiform 31

GEOLOGICAL MAP (BACK POCKET)

Map 2512 (coloured)—Dalhousie Lake Area, Frontenac and Lanark Counties. Scale 1:31 680

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			CONVERSION FROM IMPERIAL TO SI		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm^2	0.155 0	square inches	1 square inch	**6.451 6**	cm^2
1 m^2	10.763 9	square feet	1 square foot	**0.092 903 04**	m^2
1 km^2	0.386 10	square miles	1 square mile	2.589 988	km^2
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm^3	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm^3
1 m^3	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m^3
1 m^3	1.308 0	cubic yards	1 cubic yard	0.764 555	m^3
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of the Dalhousie Lake Area Frontenac and Lanark Counties

by
Liba Pauk

Geologist, Ontario Geological Survey, Precambrian Section, Ministry of Northern Development and Mines, Toronto.

Manuscript approved for publicaton by Burkhard O. Dressler, Acting Chief Geologist, July 30, 1984. This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

Abstract

The Dalhousie Lake area covers about 250 km^2 and is located some 62 km north of Kingston and 67 km southwest of Ottawa.

All of the bedrock in the map area is of Late Precambrian age. The oldest rocks are metavolcanics and metasediments of the Grenville Supergroup. The metavolcanics range in composition from basalt to andesite; sedimentary rocks are feldspathic sandstone and wacke, quartzite, calcareous mudstone and wacke, and carbonate rocks. Metaconglomerate of the younger Flinton Group is limited to a narrow band in the southwestern corner of the region. The older stratified lithologies have been intruded by early tectonic to syntectonic felsic to mafic intrusive bodies. These rocks were folded by at least 2 phases of deformation, metamorphosed, and intruded by late tectonic felsic intrusive rocks.

A major fault zone, the Robertson Lake Shear Zone, transects the map area from south-southwest to north-central.

The area northwest of the Robertson Lake Shear Zone shows intensive deformation dominated by northeastward trending small- and large-scale folds. Southeast of the fault zone the stratified lithologies display northeastward trending more or less homoclinal structures with deviations mainly along the intrusions. Deposits of iron and tremolite-talc occur in the area. Potential exists for uranium, tremolite, calcite marble, and possibly copper and gold.

Geology of the Dalhousie Lake Area, Frontenac and Lanark Counties, by Liba Pauk, Ontario Geological Survey Report 245, 57p. Published 1989 ISBN 0-7729-1037-5.

Résumé

La région du lac Dalhousie a une superficie d'environ 250 km^2, elle est située à quelque 62 km au nord de Kingston et à 67 km au sud-ouest d'Ottawa.

L'ensemble du socle rocheux de la région représentée par la carte date de l'ère précambrienne. Les roches les plus anciennes sont des roches métavolcaniques et métasédimentaires du super groupe de Grenville. La composition des roches métavolcaniques va du basalt à l'andésite, les roches sédimentaires sont formées de grès feldspathiques et de wacke, de quartzite, de pélite calcaire et de wacke, et de carbonate. Le métaconglomérat du groupe de Flinton, plus récent, se limite à une bande étroite dans le coin sud-ouest de la région. Les lithologogies stratifiées plus anciennes sont entrecoupées d'intrusions de roches felsiques à mafiques tectoniques à syntectoniques anciennes. Ces roches se sont plissées à la suite d'au moins deux phases de déformation, puis elles se sont métamorphosées et sont entrecoupées de roches intrusives felsiques tectoniques récentes.

Une zone de faille importante, la zone de Robertson Lake Shear, sectionne la région représentée par la carte du sud-sud-ouest au centre-nord.

La région nord-ouest de la zone de Robertson Lake Shear présente une forte déformation, dominée par des plis mineurs et majeurs orientés vers le nord-est. Au sud-est de la zone de faille, les lithologies stratifiées présentent des structures plus ou moins homoclinales orientées vers le nord-est, comportant des déviations surtout le long des intrusions. On trouve dans cette région des gisements de fer et de trémolite-talc. Il est possible qu'il y ait de l'uranium, de la trémolite, du marbre calcaire et probablement du cuivre et de l'or.

Introduction

Area, Location, Means of Access

The map area covers approximately 250 km^2, lies in the Frontenac and Lanark Counties area, and is bounded by 44°52'30"N and 45°00'N Latitudes, and 76°30'W and 76°45'W Longitudes. The centre of the area is located about 62 km north of Kingston and about 67 km southwest of Ottawa. The village of Elphin lies near the centre of the area. Access to the area is via Highway 509 from the southwest and by Lanark County Road 12 from the east. A network of tourist and concession roads provide good access to much of the area. The Mississippi River which traverses the map area from the west to the east is navigable by canoe through all of the map area. The abandoned Kingston and Pembroke railway line (formerly belonging to Canadian Pacific Railway) passes through the map area in an approximately north-south direction and provides access to the otherwise relatively remote northwestern part of area.

Present Geological Investigations

Geological mapping of the Dalhousie Lake area at a scale of 1:15 840, was carried out by the author and her assistants during the summer of 1981. The base maps were provided by the Lands and Waters Group, Ministry of Natural Resources and are enlargements of The National Topographic Series, provisional Map 31 C/15. Mapping was carried out by pace-and-compass traverses run approximately 400 to 600 m apart and at right angles to the strike of rock units. The geological data were plotted on acetate overlays fitted on 1:15 840 air photographs and transferred to the base map of the same scale. Old mine workings and known occurrences of metallic and nonmetallic minerals were studied in detail. A scintillometer was used to detect and assess uranium mineralization in the western part of the area. The igneous plutonic rocks described in this report are classified according to the classification scheme proposed by A.L. Streckeisen (1967). The igneous rocks were chemically stained to aid the visual estimate of modal compositions.

Acknowledgments

The author was assisted in the field by S. Allen, B. Carswell, B. Jennings, G. Robertson, and J. Wolkow. Their cooperation was much appreciated. G. Robertson was senior assistant and carried out independent work in many parts of the area. The many courtesies extended to the field party by local residents are gratefully

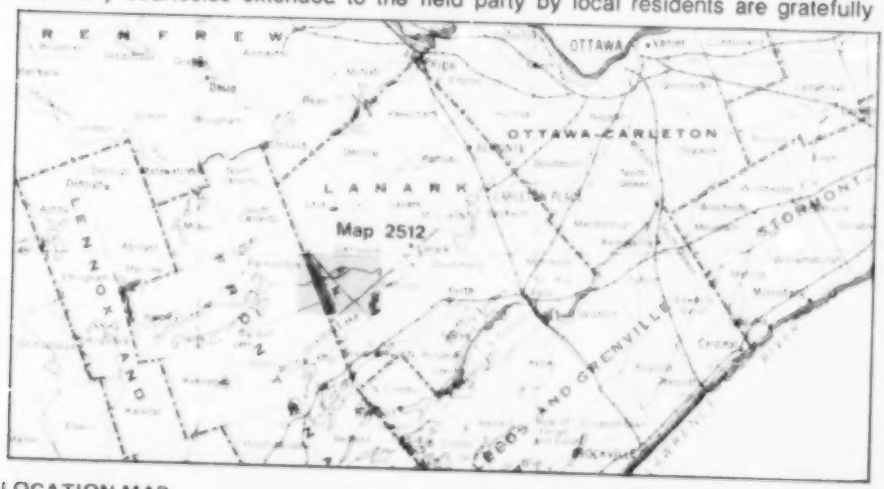

Figure 1. *Key map showing the location of the Dalhousie Lake area.*

acknowledged. The author thanks J. Wood, Ontario Geological Survey, Toronto for fruitful discussions and K. Ford, Geological Survey of Canada, Ottawa for discussions on uranium mineralizations in the area. J. Gillett, geologist, Ram Petroleums Limited provided the author with information on a talc-tremolite deposit.

Previous Geological Work and Prospecting Activity

R.W. Ells (1904) examined some parts of the map area along the roads, canoe routes, and along the Kingston and Pembroke railway line as a part of the Geological Survey of Canada program of mapping the area south of the Ottawa River. He described the limestone belt in Dalhousie Township, separated from the northwestern marble belt in Clarendon Township by diorite-diabase rocks and by large masses of reddish granite. The section on Millers Lake to the west of the railway bridge was described as containing granite gneiss with some bands of hornblende gneiss, a band of limestone, and another thick band of reddish foliated granite-gneiss. Along the Kingston and Pembroke railway route which in places runs parallel and in places across the strike of rock units, Ells (1904) described the succession from the south to the north as comprising hornblende gneiss, reddish granite, diorite, several bands of limestone, and a band of reddish granite with bands of hornblende gneiss. A second band of limestone in the northwestern part of the region was described by Ells (1904).

W.D. Harding (1947) mapped Olden, Oso, and other townships located southwest of the map area. A small segment of the present south-central region, underlain by gabbro is included in this report.

Systematic geological mapping of Palmerston, Dalhousie, and a few adjacent townships was first carried out by B.L. Smith (1958) between 1949 and 1951 at a scale of 1 inch to 1 mile. Smith outlined the major lithologic and structural units. He described a zone of intensive shearing in the Robertsville area and farther northeast in the Lavant area and named it the "Robertson Lake Shear Zone". The map area is a part of the Kaladar-Dalhousie Trough (Hewitt 1956).

All of the present study area is included in the regional compilation of the Madoc-Gananoque area (Hewitt 1964).

K. Sethuraman and J.M. Moore Jr. (1973), using the basis of colour index and texture, subdivided the metavolcanics occurring between Bishop Corners (a village about 36 km southwest of the map area) and Donaldson (a village in the northwestern part of the map area), into 5 petrographic units. They established 5 metamorphic zones (4 of them outside of the map area) and recorded an increase in metamorphic grade in a northeastward direction. The southeastern area of the Sethuraman and Moore study includes the extreme western part of the Dalhousie Lake area.

D. Chapman-Kamilli (1974) carried out a mineralogical textural study of the Cross Lake Pluton (called the Northbrook Batholith in this report). She recorded mineralogical and textural changes that are due to the increasing metamorphic grade. The area to the south and southwest of the map region has been mapped recently by J.M. Wolff (1979, 1981).

History of Mineral Exploration

Mineral exploration within the map area dates back to the 1880s and is closely related to the construction of the Kingston to Pembroke railway. The Robertsville (Mississippi) mine is 1 of a few iron deposits which have been discovered and developed along this railway route. The mine originally owned by The Mississippi Mining Company Limited operated in the 1880s. An option was taken on this property by Minnesota Huron Iron Company Limited in 1957 and the company conducted a dip needle survey on the property (Smith 1958).

In the late 1940s Picamine Copper Gold Mines Limited investigated copper occurrences southeast of the village of Robertsville. The period between 1952 and 1958 saw more prospecting for copper adjacent and southeast of the Picamine Copper Gold Mines Limited property (Assessment Files Research Office, Ontario Geological Survey, Toronto). In the late 1930s J.A. Cummings worked on a

tremolite-talc deposit located about 3.5 km west of Robertsville. Several shallow pits were blasted. In the early 1970s Ram Petroleums Limited acquired this tremolite-talc property and carried out a comprehensive exploration program and later feasibility studies which led to the opening of the mine in 1978. The mine has been in production since then (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In the 1940s Marlhill Mines Limited quarried a vein of coarse crystalline calcite 2 km west of the village of Robertsville (Smith 1958).

Since the mid-50s exploration activity in the area has been focused on uranium occurrences in the pegmatites in the southwestern and the central-western parts of the map area. Large parcels of land were staked and many properties were studied in detail by reconnaissance, ground, and/or airborne radiometric surveys, and by trenching and sampling. Diamond drilling programs were carried out on most of the properties. The most recent exploration activity in this area was a diamond drilling program for uranium conducted by the AJM Explorations Limited (1) (numbers in parentheses following property names indicate location on geological map in back pocket) and by Groundstar Resources Limited (5) in 1980 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Physiography

The elevation above sea level in the map area ranges from 160 m to 300 m. A distinct difference in topography exists between the northwestern and southeastern parts of the region. The southeastern part is gently rolling, hilly farmland underlain essentially by marble. The central part of the region occupied by the Lavant Gabbro Complex and the area farther northwest underlain mostly by plutonic rocks are rugged with an average elevation of about 280 m and with higher local relief.

Many streams and valleys parallel northeastward striking structural trends and east-westward striking fault zones.

Drainage is into the Mississippi River which flows to the Ottawa River.

Most of the plutonic bodies provide excellent bedrock exposures whereas the supracrustal rocks are rather poorly exposed, and commonly lie in swampy depressions. Areas underlain by pure marble are rather flat, show little outcrop, are in farmland, or are covered by swamp. In several excellent road-cuts along Highway 509, the Addington Complex and carbonate and clastic metasediments are exposed. Road-cuts along the Lanark County Road provide an east-west section across the central and eastern map area.

General Geology

The Dalhousie Lake area lies within the Central Metasedimentary Belt (Wynne-Edwards 1972) of the Grenville Province. It straddles the boundaries of the Hastings Basin (segment IV.b.) and the Frontenac Axis (segment IV.c.). The map area forms part of the Kaladar-Dalhousie Trough (Hewitt 1956). All of the units in the map area are Late Precambrian in age.

The metavolcanics and most of the metasediments are considered to belong to the Grenville Supergroup; the metasediments which are correlated by the author with the younger Flinton Group (Moore and Thompson 1972) are restricted to a narrow band of metaconglomerate in the southwestern part of the area. A variety of syntectonic to late tectonic felsic to mafic intrusive rocks intruded the supracrustal sequence in the western, central, and southwestern parts of the region.

The supracrustal rocks have a general northeastward trend with deviations around the intrusions and the fold hinges. The intrusive bodies subdivide the supracrustal belt into a western, a central, and an eastern belt. The western belt contains approximately equal amounts of metavolcanics, clastic metasediments, and carbonate metasediments. The metavolcanics comprise fine- to medium-grained biotite-hornblende-plagioclase ± quartz gneiss and hornblende-plagioclase ± garnet gneiss. These gneisses have colour indices of 30 to 50 and are considered to be of intermediate to mafic affinities. The clastic metasediments are quartzofeldspathic sandstone and wacke. The carbonate metasediments comprise marble, dolomitic marble, and impure marble that contains tremolite, actinolite, and phlogopite. Lenses of quartzite are present within the marble in a few places. The narrow, 500 to 1200 m wide central belt of the supracrustal rocks comprises metavolcanics and a variety of carbonate and clastic metasediments. The metavolcanics form narrow (100 to 300 m) discontinuous layers in the northern and central part and a thicker band (500 m) in the southern part of the belt.

The metasediments range in composition from calcitic and dolomitic limestone to calcareous mudstone and wacke and quartzofeldspathic wacke. All of the above units are intercalated which is a reflection of their deposition in an unstable sedimentary basin. The texture, structure, and mineralogy of most of these rocks are effected by shearing, fracturing, and secondary alteration especially in the major northeastward striking fault zone, i.e. the Robertson Lake Shear Zone that passes through this belt of supracrustal rocks. The carbonate metasediments are the predominant rock type in the eastern belt of supracrustal rocks. Only narrow isolated layers of calcareous clastic metasediments and mafic metavolcanics are present here.

The supracrustal rocks also form narrow (up to 400 m wide) both continuous and discontinuous layers and lenses within the Addington Complex where they are composed of mafic to felsic gneiss and schist. These are considered by the author to be in part metavolcanic, in part metasedimentary in origin. The rocks range from dark biotite - hornblende - plagioclase ±quartz gneiss and schist to grey biotite - plagioclase - quartz gneiss and schist. Commonly several compositional varieties are found within a single outcrop.

Nearly two thirds of the map area are underlain by intrusive rocks.

The syntectonic felsic plutonic activity in the map area is represented by 2 large bodies, the Northbrook Batholith and the Addington Complex.

The Northbrook Batholith comprises lineated to foliated gneiss of biotite granodiorite to biotite and biotite-hornblende quartz diorite composition. Only a small part of this large northeastward trending body extends into the western and northwestern parts of the area.

The Addington Complex forms an approximately 4 km wide belt that crosses the western part of the region. The rocks of the complex are predominantly biotite granite to quartz monzonite and less commonly granodiorite. In contrast to the rocks of the Northbrook Batholith the rocks of the Addington Complex are strongly foliated and stratified, consisting of alternating, texturally heterogeneous, biotite-rich and biotite-poor layers. As mentioned above, the complex encloses many continuous to discontinuous comformable layers and lenses of supracrustal rocks.

TABLE 1. TABLE OF LITHOLOGIC UNITS OF THE DALHOUSIE LAKE AREA.

PHANEROZOIC

CENOZOIC

QUATERNARY

Pleistocene and Recent
Outwash deposits, sand, silt, clay, till, and swamp deposits

Unconformity

PRECAMBRIAN

LATE PRECAMBRIAN

LATE INTRUSIVE ROCKS

LATE TECTONIC FELSIC INTRUSIVE ROCKS
Pegmatite dikes and sills.
Barbers Lake Intrusion: fine- and medium-grained biotite-muscovite granite.
Elphin Intrusion: diorite and granodiorite with granite veins, hybrid phases, medium-grained biotite granite, locally biotite monzonite to syenite

Intrusive Contact

FLINTON GROUP

Bishop Corners Formation
Polymictic metaconglomerate, locally migmatized

Unconformity

EARLY INTRUSIVE ROCKS

EARLY TECTONIC TO SYNTECTONIC MAFIC AND INTERMEDIATE INTRUSIVE ROCKS
Lavant Gabbro Complex: gabbro, locally very coarse grained to pegmatitic gabbro, gabbro-diorite, diorite, granodiorite, quartz diorite; granite-pegmatite and granodiorite aplite dikes; locally contaminated granite and syenite, locally hybrid rocks; locally fine-grained foliated hornblende ± biotite plagioclase gneiss; fine-grained diabase dikes with granite veins.
Dalhousie Amphibolite Complex: pink and grey biotite-hornblende-quartz dioritic gneiss; diorite gneiss; fine-, medium- to coarse-grained amphibolite; locally very coarse grained gabbro-amphibolite; locally hornblende ± magnetite ± biotite schist; anorthositic gneiss; locally strongly foliated and lineated amphibolite and anorthositic gneiss; pyroxenite dikes, coarse-grained pyroxenite, pyroxene-hornblende gabbro-amphibolite; locally layers and dikes of granodioritic and granitic gneiss

EARLY TECTONIC TO SYNTECTONIC METAMORPHOSED FELSIC INTRUSIVE ROCKS
Addington Complex: weakly foliated, medium- to fine-grained, pink biotite granite and quartz monzonite gneiss; foliated medium-grained biotite granite; quartz monzonite gneiss; fine-grained, biotite-rich well-foliated granite, quartz monzonite, and granodiorite gneiss

Fault Contact

Northbrook Batholith: lineated to weakly foliated medium-grained biotite granodiorite and trondhjemite gneiss; medium- to coarse-grained foliated biotite trondhjemite and biotite granodiorite gneiss; fine-grained well-foliated biotite trondhjemite gneiss; medium-grained hornblende-biotite trondhjemite to diorite gneiss

Intrusive Contact

METASEDIMENTS AND METAVOLCANICS

CARBONATE METASEDIMENTS

White and creamy calcitic marble; white, grey, and creamy dolomitic marble; locally silty dolomitic marble; grey and white banded calcitic marble; marble and dolomitic marble with tremolite, diopside, phlogopite, actinolite, graphite, marble and dolomitic marble with layers and lenses of quartzite; locally tremolite reaction rims at the contact of marble with quartzite; locally cherty layers; diopside;calcite gneiss; locally fractured marble; pyroxene-garnet-calcite ± magnetite assemblage; tremolite ± talc ± phlogopite ± actinolite ± diopside schist

INTERLAYERED GNEISSIC METASEDIMENTARY AND METAVOLCANIC ROCKS

Medium-grained, biotite-hornblende-plagioclase gneiss; fine- to medium-grained biotite-quartz-plagioclase gneiss, locally with minor hornblende; fine-grained, biotite-rich quartz-plagioclase gneiss to schists, locally rusty biotite-hornblende schist; fine- to medium-grained biotite-hornblende schist; medium-grained graphite-diopside-plagioclase-scapolite-quartz schist; quartzite.

CLASTIC METASEDIMENTS

CALCAREOUS CLASTIC METASEDIMENTS

Limy mudstone, locally sheared; calcareous wacke,locally sheared; marly sediments: hornblende-biotite-carbonate-plagioclase schist.

SILICEOUS CLASTIC METASEDIMENTS

Medium- to fine-grained biotite-quartz-plagioclase ± hornblende ± muscovite gneiss; biotite-hornblende-quartz-plagioclase ± muscovite schist; fine-grained pyritic plagioclase-quartz ± biotite ± muscovite metasandstone; locally rusty pyritic metasandstone; fine- to medium-grained rusty plagioclase-quartz-biotite ± hornblende gneiss to schist; diopside-scapolite-microcline-quartz-plagioclase metasandstone; fine-grained, dark grey, biotite-quartz ± garnet schist to slate; locally mylonitized metasediments in the Robertson Lake Shear Zone.

METAVOLCANICS

MAFIC TO INTERMEDIATE METAVOLCANICS

Fine- to medium-grained hornblende-plagioclase ± garnet gneiss; medium- to coarse-grained hornblende-plagioclase ± garnet gneiss; porphyroblastic hornblende-plagioclase ± biotite gneiss (porphyroblasts are of biotite or hornblende); medium- to fine-grained quartz-biotite-hornblende-plagioclase gneiss; locally laminated biotite-hornblende-plagioclase ± quartz gneiss (metatuff); locally mylonitized metavolcanics in the Robertson Lake Shear Zone - unsubdivided; dark green, fine-grained hornblende-plagioclase ± biotite schist.

The Dalhousie Amphibolite Complex and the Lavant Gabbro Complex are post-Addington Complex and post-Northbrook Batholith in age and were emplaced in the southwestern and the central parts of the region respectively. These 2 igneous complexes although located less than 1 km apart, differ in both composition and texture, and therefore probably are not contemporaneous. The Dalhousie Amphibolite Complex ranges in composition from pyroxenite, gabbro, anorthosite to diorite and granodiorite. Most parts of the body are completely recrystallized and exhibit a granoblastic foliated fabric. The Lavant Gabbro Complex occupies the central part of the map area. It is a composite body of batholithic dimension containing gabbro, gabbro-diorite, diorite, quartz diorite, granodiorite, and narrow dikes of pegmatite and aplite. The rock textures vary from fine, medium, coarse to very coarse grained. Patches of several textural and compositional varieties may be found within a single outcrop. Some of the fine-grained, foliated phases within the Lavant Gabbro Complex represent roof pendants of supracrustal rocks. The Lavant Gabbro rocks display mostly primary mineralogy and textures that are more or less deformed. Rock compositions and textures suggest that several subsequent intrusive stages are responsible for the heterogeneity of the Lavant Gabbro Complex.

Middle to late tectonic felsic plutonic activity is documented by the small igneous bodies of the Elphin Intrusion and the Barbers Lake Intrusion and by numerous pegmatite sills and dikes which intrude most lithologic units throughout the map area. The Elphin Intrusion intrudes the Lavant Gabbro Complex in the vicinity of the village of Elphin. It is comprised of unfoliated medium- to fine-grained biotite granite and minor syenite. A large number of hybrid rock types and inclusions of the Lavant Gabbro rocks are incorporated within this intrusion. Small offshoots of the Elphin Intrusion are found within the southeastern part of the Lavant Gabbro Complex.

The Barbers Lake Intrusion is a small, almost circular igneous body which intrudes the Dalhousie Amphibolite Complex and the supracrustal rocks in the southeastern part of the area. It is fairly homogeneous consisting of medium- to fine-grained massive, biotite-muscovite granite.

The rocks in the map area underwent regional metamorphism during the Late Precambrian. The mineral assemblages in the supracrustal rocks, which are most susceptible to pressure and temperature changes, indicate that the rocks in the area were metamorphosed under upper almandine-amphibolite facies conditions. Combined effects of regional and thermal metamorphism were responsible for the recrystallization of the Dalhousie Amphibolite Complex.

The rocks in the map area have been subjected to at least 2 episodes of post-Flinton-deposition deformation. The area is divided into 2 structural zones by a north-northeastward trending fault shear zone, the Robertson Lake Shear Zone (Smith 1958). West of the shear zone the supracrustal rocks have been intensively folded into northeastward trending zones. Folds here are isoclinal to recumbent and foliations are essentially parallel to the original bedding planes. A second phase of deformation produced northeastward striking megascopic folds with an axial plane foliation that dips gently to moderately (15 to 40°) to the south and that plunges (about 25°) to the northeast. Small parts of 3 of these megastructures are exposed along the western boundary of the map area. The complete structures are well exposed in the adjoining Ardoch Area (Pauk 1982b). The area southeast of the shear zone belongs to the frontier part of the Frontenac Axis. It is dominated by several plutonic bodies and by carbonate metasediments. These metasediments display northeastward trending stratiform foliations (F1). Dips are shallow to moderate essentially to the southeast. A few changes in strikes and dips of rocks may indicate the presence of D_2 structures, which are difficult to trace because of the lack of marker horizons within the metasediments. In the southeastern part of the map area the supracrustal rocks have been deformed around the Dalhousie Amphibolite Complex.

A prominent system of approximately east-westward trending transverse faults cuts across the western half of the region. The Robertson Lake Shear Zone, a dip-slip fault transects the map area. It passes through the villages of Robertsville

and Mississippi Station and strikes N15E to N30E and dips 30 to 60 degrees east. Within the shear zone, metavolcanics, carbonate and clastic metasediments, gneisses of the Addington Complex, and rocks of the Lavant Gabbro Complex are mylonitized. Outside the map area, the Robertson Lake Shear Zone extends to the northeast (Smith 1958) and to the southwest for a total length of about 80 km (Wolff 1979, 1981). Two joint systems can be recognized in the area. The prevailing system strikes N45W to N60W; the second, less prominent 1 strikes about N80W to N90W. Both systems essentially dip vertically.

LATE PRECAMBRIAN

METAVOLCANICS AND METASEDIMENTS

Metavolcanics

The metavolcanics are found in 3 separate belts of supracrustal rocks which occupy the western, central, and eastern parts of the region. Only in the western belt do they make up a significant volume of the supracrustal sequence. The common interlayering of metavolcanics and metasediments reflects a more or less contemporaneous volcanic-sedimentary activity. Some of the interlayering is possibly not original but caused by infolding. All of the metavolcanics have been metamorphosed under almandine-amphibolite facies regional metamorphic conditions. Primary structural, textural, and mineralogical characteristics have been largely destroyed by the metamorphism. The mafic metavolcanics comprise dark coloured hornblende-plagioclase gneisses with a colour index of 40 to 50, whereas the intermediate metavolcanics are represented by lighter coloured biotite - quartz - hornblende - plagioclase gneisses (colour index of 20 to 40). Fine grain-size enhances dark colours. Finer grained metavolcanics, therefore, have generally darker colour relative to their chemical composition and the colour index is not a reliable guide for field identification. Therefore and because of a common interlayering of mafic and intermediate metavolcanics, these rocks are classed as 1 map unit in the present report.

Mafic to Intermediate Metavolcanics

Mafic to intermediate metavolcanics occur in the western and central belts of supracrustal rocks whereas in the eastern supracrustal belt only mafic metavolcanics are present. The metavolcanics within the central supracrustal belt are intensively deformed as the Robertson Lake Shear Zone passes through this region.

The colour of the mafic to intermediate metavolcanics varies from dark green to grey-green. Fine-grained metavolcanics display generally darker colours than coarse-grained varieties. The grain-size ranges from 0.30 to 1 mm with some to 6 mm. The metavolcanics are foliated, gneissic to schistose.

Foliations are defined by a subparallel alignment of prismatic hornblende and biotite or by segregations of the mafic and felsic minerals. Most metavolcanics are comprised of fine- to medium-grained and medium- to coarse-grained hornblende-plagioclase gneisses (map units 1a, 1b). In thin section they consist essentially of granoblastic plagioclase and subidioblastic hornblende. Plagioclase is untwinned to poorly twinned with pericline twinning being predominant. Compositions of plagioclase vary from An_{36} to An_{66} and the proportion of plagioclase to hornblende is approximately 50:50. Common accessory minerals are magnetite, apatite, sphene, and biotite. In places, pyrite and pyrrhotite are also present.

Magnetite rods are commonly well aligned. White mica and carbonate occur as alteration products of plagioclase and biotite. Chlorite replaces hornblende in places. Some of the metavolcanics are porphyroblastic (map unit 1c) containing large aligned grains and clusters of hornblende and garnet and lenticular accumulations of granoblastic plagioclase which might have been formed by the recrystallization of original plagioclase phenocrysts. In general all of the hornblende-plagioclase gneisses (with the exception of the porphyroblastic variet-

ies) display homeoblastic fabric with straight to slightly curved grain boundaries which are indicative of equilibrium conditions.

The intermediate metavolcanics (map unit 1d) are represented by medium- to fine-grained biotite - hornblende - plagioclase - gneiss. They are generally lighter in colour and compositionally differ from the mafic metavolcanics by the presence of ubiquitous quartz (5 to 15 percent), biotite (1 to 10 percent) and the presence of more sodic plagioclase (An_{30}). Accessories are magnetite, sulphide, apatite, sphene, and microcline.

The foliation is defined by segregation bands and lenses of mafic and felsic minerals, segregation layers and lenses of quartz, and by the subparallel alignment of hornblende, biotite, and iron oxide minerals. Locally well-laminated biotite - quartz - hornblende plagioclase gneisses were encountered that might have originated from tuffaceous rocks. Both the mafic and the intermediate metavolcanics are found interlayered in the western and the central supracrustal belts and a narrow layer of these rocks is also exposed along the Dalhousie Amphibolite Complex east of the village of McDonalds Corners.

Map unit 1e which comprises mylonitized mafic to intermediate metavolcanics lies within the Robertson Lake Shear Zone in the central belt of supracrustal rocks. These rocks were strongly affected by cataclastic deformation, secondary alteration, and by the introduction of silica and calcium carbonate. Their metamorphic textures were partly to fully destroyed and their composition largely altered. The felsic rocks were crushed, granulated, and display mortar and sheared fabric. The mafic rocks have been altered to fine-grained deformed aggregates of chlorite, epidote, and carbonate. Where the identification of the type of metavolcanics was reasonably possible, both codes are used on the map (see back pocket). The first code indicates the rock type and the second indicates deformation (e.g., 1a, e is a medium hornblende-plagioclase gneiss in a shear zone).

Dark green homogeneous hornblende schists are wrapped around the Dalhousie Amphibolite Complex particularly along its southwest border (map unit 1f). East of Crains Lake this unit is intercalated with marble. The schists are fine grained (0.75 to 1 mm) and composed essentially of an interlocking mosaic of andesine (45 percent), small subidioblastic grains of dark green hornblende (50 percent), up to 5 percent iron oxide or sphene, and accessory apatite. Lenses and streaks of granoblastic-polygonal plagioclase ranging from 3 to 6 mm in length were found in 2 locations. These lenses probably replaced original plagioclase phenocrysts.

Metasediments

Clastic Metasediments

All of the clastic metasediments in the region have been metamorphosed under almandine-amphibolite facies conditions and are now represented by a variety of fine- to medium-grained, felsic to mafic gneisses and schists. The clastic metasediments are subdivided on the basis of their mineral composition into siliceous clastic metasediments and calcareous clastic metasediments.

The siliceous clastic metasediments form extensive layers in the western belt of supracrustal rocks; they are scarce in the central supracrustal belt and practically absent from the eastern belt of supracrustal rocks. The calcareous clastic metasediments make up significant parts of the central supracrustal belt.In the eastern belt, that is composed of predominantly carbonate rocks, the calcareous clastic rocks are erratically distributed.

Siliceous Clastic Metasediments The majority of the siliceous clastic metasediments are confined to the western belt of supracrustal rocks, and in particular, to the hinge of the Cross Lake Antiform. The original sediments were comprised of poorly sorted sandy and silty arkose, calcareous feldspathic sandstone, wacke, and small amounts of well-sorted quartz-rich sandstone. These rocks were deformed and metamorphosed under almandine-amphibolite facies conditions and are now represented by plagioclase-quartz gneiss and schist and quartzofeld-

spathic gneiss and schist with variable proportions of muscovite, hornblende, and/or diopside.

All of the siliceous clastic metasediments are intercalated with each other and also with the other supracrustal rocks, particularly with carbonate rocks. Biotite - quartz - plagioclase gneiss (map unit 2a) is a well-foliated, light grey, fine- to medium-grained gneiss containing variable amounts of biotite. Its colour progressively darkens with increasing biotite content and very biotite-rich rocks were mapped as biotite schists (map unit 2b). Smaller amounts of hornblende or muscovite accompany biotite in some of these rocks. Plagioclase is the predominant mineral and in the light coloured varieties may constitute up to 75 percent of the rock. However, varieties containing about the same proportions of plagioclase and quartz or more quartz than plagioclase are also present. In thin section the rocks exhibit a granoblastic-polygonal to granoblastic-elongate fabric. The felsic minerals are bounded by straight to curved grain boundaries and in many places grain shapes are almost isometric to round. The foliation is defined by tabular and prismatic minerals such as biotite, muscovite and hornblende, and by elongate quartz grains. Compositional gneissic banding is common. Common as accessories are sphene, apatite, and pyrite.

Rusty weathering gneiss and schist of similar composition as the rocks described above, containing up to 5 percent pyrite, were mapped as map unit 2d.

Map unit 2c consists of a white to white grey, fine- to medium-grained sandstone and siltstone unit. It is well exposed along Highway 509 in the hinge of the Cross Lake Antiform. The rocks consist basically of fine- to medium-grained plagioclase and smaller amounts of quartz. Other major constituents are pyrite and muscovite accounting for about 10 percent of the rock. The sandstones are intercalated with marble. At marble-sandstone contacts calc-silicate is developed consisting of quartz, plagioclase, microcline, scapolite, diopside, tremolite, and pyrite.

Map unit 2d is comprised of rusty weathering, fine- to medium-grained, schist, gneiss, and weakly foliated to banded, metasandstone of calc-silicate composition. It is not associated with the layers of marble. In thin section the rock is seen to consist of a heteroblastic matrix of plagioclase, quartz, scapolite, and microcline. Diopside and tremolite that have approximately the same grain-size as the felsic minerals constitute about 15 percent of the rock. Diopside reacts with plagioclase to form idocrase. This reaction is probably retrograde as it requires water. The other thin sections of rocks of unit 2d contain more microcline at the expense of plagioclase. The microcline is unaltered and appears to have replaced the plagioclase. Myrmekite is commonly developed at the contact of microcline and plagioclase. Microcline is possibly metasomatic in origin and the source for the potassium is believed to be pegmatites that intruded the calc-silicate rocks in many places.

Map unit 2e forms a narrow layer in the southwestern part of the central belt of supracrustal rocks. It is composed of a dark grey, very fine grained slaty rock. It consists of quartz 0.1 to 0.2 mm in size, and little plagioclase. Biotite and subparallel stringers of opaque minerals define the foliation. Biotite-rich layers show numerous small (0.50 mm) idioblastic grains of garnet. Within the Robertson Lake Shear Zone rocks of map unit 2e are deformed, commonly somewhat carbonatized, and garnet and biotite are chloritized.

Calcareous Clastic Metasediments

Fine- to medium-grained, dark green rocks consisting essentially of hornblende, biotite, plagioclase, and carbonate have probably originated from the calcareous mudstone, calcareous wacke, and marly sediments.

In the central supracrustal belt, limy mudstone (map unit 3a) and calcareous wacke (map unit 3b) are interlayered with carbonate metasediments and metavolcanics. The marly metasediments (map unit 3c) are confined to narrow layers within the eastern belt of predominantly carbonate rocks. Large exposures of these rocks occur south of the southern map boundary (Wolff 1981).

Calcareous mudstones (map unit 3a) are very fine grained dark green massive rocks. Microscopically these are distinguished from the metavolcanics by the dense and massive texture and by the presence of ubiquitous carbonate and pyrite. Most of these rocks lie within the Robertson Lake Shear Zone where they were subjected to intense cataclastic deformation, alteration, carbonatization, and silicification.

In thin section, the rocks are composed of hornblende, chlorite after biotite, carbonate, and smaller amounts of plagioclase and quartz. Larger grains (to 1.5 mm) and stringers of iron oxide and sulphide minerals, comprise about 10 percent of the rock.

Similar in composition to rocks of map unit 3a are calcareous wackes (map unit 3b). They are banded and carry more quartz and feldspar than the mudstones.

A thick sequence of marbles exposed in the eastern part of the map area contains narrow lenses and layers of marly metasediments, i.e. calcareous pelitic schist and biotite - hornblende - plagioclase- carbonate schist. These schistose rocks are fine to medium grained and grey-green.

In thin section, they are composed of well-recrystallized hornblende, biotite, carbonate, plagioclase, and small amounts of quartz. Common accessory minerals are sphene and tourmaline. The foliation is caused by subparallel hornblende and biotite and is parallel to the schist-marble interlayering. The biotite-hornblende schist layers within the somewhat more competent calc-silicate and marble layers, in places are microscopically and macroscopically drag folded.

Interlayered Gneissic Metasediments and Metavolcanics

Interlayered metasedimentary and metavolcanic gneisses forming 1.0 to 400 m wide concordant layers and lenses within the Addington Complex are grouped in 1 map unit (4). The rocks are represented by a variety of mafic and felsic gneisses and schists which resemble the metasediments and metavolcanics of map units 1 and 2. In places carbonate metasediments are found in this sequence. The contact of the metasediments and metavolcanics with the rocks of the Addington Complex is gradational through a zone of potassium metasomatized host rock. Some sharp contacts, however, with no apparent alteration of the supracrustal rock were also observed. The variation in the character of contact zones is probably due to the difference in susceptibility of various rock compositions and textures to metasomatic alteration. In general, the siliceous clastic metasediments display more gradational contacts than metavolcanics. The map unit 4a, mafic to intermediate metavolcanics includes fine- to medium-grained dark green to grey-green hornblende-plagioclase gneiss and biotite-hornblende-plagioclase ± quartz gneiss. Light grey to grey, fine- to medium-grained biotite-quartz-plagioclase gneiss with hornblende locally (map unit 4b) and hornblende-biotite-quartz-plagioclase gneiss and schist (map unit 4c) represent siliceous clastic metasediments. Locally fine-grained quartz-rich plagioclase metasandstone and quartzite are present (map unit 4f). Medium grey to green-grey commonly rusty weathering plagioclase-quartz gneiss and schist containing varied proportions of hornblende and biotite may be in part of metavolcanic and in part of metasedimentary origin (map unit 4d). Coarse-grained schists carrying up to 70 percent combined hornblende and biotite were found in a few places. The grain size of schists varies from medium to coarse whereas gneisses are mostly medium grained.

Map unit 4e is a very distinct, rusty weathering schistose calc-silicate sandstone containing about 8 to 10 percent graphite. In thin section, the rock is seen to consist of homeoblastic plagioclase, scapolite, quartz, microcline, diopside, tremolite, and idocrase with accessory apatite and sphene. The grain-size of the major minerals ranges from 0.75 to 1 mm. All minerals display sutured grain boundaries signifying non-equilibrium conditions. The foliation is well defined by subparallel graphite, laths of tremolite, and by strained and stretched quartz. This rock has practically the same mineral composition as the calc-silicate sandstone of map unit 2d. Rocks of map unit 2d contain pyrite; rocks of unit 4e graphite.

Carbonate Metasediments

The carbonate metasediments are interlayered with clastic metasediments and metavolcanics in the western and central belts of supracrustal rocks, more extensive and continuous exposures of carbonate metasediments are present east of the Lavant Gabbro Complex in the eastern part of the map area.

Map units 5a and 5b comprise calcitic marble and dolomitic marble respectively. Both marble and dolomitic marble are usually medium to coarse grained and in thin section display a granoblastic fabric. The rocks range in colour from white and buff-grey to light grey, with pink and greenish colours being less common. In general these rocks are structureless, although locally a darker lamination caused by segregation of graphite and phlogopite is developed. Generally however these carbonates are pure with no substantial amounts of calc-silicate minerals or other impurities. The mineral fabric is idioblastic to subidioblastic. More extensive layers of pure white calcite marble are present in the southeastern part of the map area.

Fine-grained grey silty dolomitic marble forms a few outcrops southwest of the village of McDonalds Corners and southeast of Gordons Hill in the eastern belt of supracrustal rocks.

Map unit 5c consists of fine-, medium-, and coarse-grained, grey and white thinly to coarsely laminated calcitic marble. Locally small amounts of phlogopite, pyrite, and graphite are present. Light and dark laminae reflect the original pure and contaminated limestone beds. This type of marble is widespread throughout the map area.

Map unit 5d comprises marble and dolomitic marble containing calc-silicate mineral assemblages. The dominant calc-silicate minerals are tremolite and phlogopite with diopside and scapolite being less common. Calc-silicate minerals are either segregated into subparallel bands or occur as lenses and irregular accumulations of large grains.

Map unit 5e consists of marble and dolomitic marble containing layers and lenses of quartzite and locally chert layers. Commonly thinner quartzite beds have been broken up and contorted and form concordant lenses within the carbonate metasediments (Photo 1). Reaction rims of white elongated crystals or crystal aggregates of tremolite have developed at carbonate quartzite interphases.

Banded diopside-calcite gneiss (map unit 5f) is confined to the areas north and southwest of the village of Donaldson where carbonate layers are intercalated with sandstones and siltstones. Banding is caused by segregation of carbonate-silicate layers and quartz to feldspathic-calc-silicate layers. The carbonate-silicate layers are usually coarser, comprised of carbonate, scapolite, diopside, and epidote. Fine-grained quartzofeldspathic-calc-silicate layers contain quartz, plagioclase, diopside, and hornblende. With an increasing proportion of quartzofeldspathic minerals, this rock grades into sandstone (map unit 2d).

Map unit 5g represents strongly fractured and sheared marble within the Robertson Lake Shear Zone.

The skarns (map unit 5h) are found at 2 locations in the west-central and southwestern parts of the region respectively. The rock consisting of flesh-coloured calcite, grossularite, diopside, quartz, and epidote was formed at the contact of a narrow zone of marble with a large body of pegmatite. Chalcopyrite mineralization is associated with calcite in this area. The skarn body is located 800 m south of Otter Lake.

The second small skarn body consisting of magnetite-andradite-hedenbergite-epidote-calcite-quartz occurs in a marble layer enclosed by the Addington Complex 600 m southwest of the southern tip of Gibsons Lake. The surface exposures of both bodies are about 2 m^2.

Map unit 5j comprises medium to very coarse grained tremolite ± talc schist, actinolite-tremolite-phlogopite schist, and actinolite-diopside rocks. It occurs together with siliceous clastic metasediments within the Addington Complex, 1.8 km west of Gibsons Lake. The tremolite-talc horizon is confined to the nose of the

Photo 1. *Light grey marble containing concordant lenses and layers of white quartzite with boudins. Reaction rims composed of tremolite are developed along the quartzite-marble interphases. Roadcut, Lanark County Road 12, 800 m east of village of Snow Road.*

synform. This tremolite-talc horizon is presently being mined by Ram Petroleums Limited (8).

EARLY INTRUSIVE ROCKS

The intrusive rocks cover substantial parts of the map area. They intrude the supracrustal rock in the western, central, and eastern parts of the region and can be subdivided on the basis of mineral composition, structural, and textural characteristics and relation to the tectonic events into 2 compositional groups: felsic and mafic; and into 2 tectonic groups; early tectonic to syntectonic, and late tectonic. The early tectonic to syntectonic intrusive rocks are both felsic and mafic and include the Northbrook Batholith and the Addington Complex located in the western part of the map area, and the Lavant Gabbro Complex and the Dalhousie Amphibolite Complex which are exposed in the central and southeastern parts of the region.

Early Tectonic to Syntectonic Metamorphosed Felsic Intrusive Rocks

Northbrook Batholith

The Northbrook Batholith (Cross Lake Pluton in 1958 report by Smith) is a large body of batholithic dimensions extending northeastward from the Northbrook and Marble Lake regions, (southwest of the map area) for about 56 km to the northwestern part of this report area. The body is separated by layers of metavolcanics into 3 major belts which emerge along the western map boundary in the Donaldson and Otter Lake area and in the southwestern part of the area. The Northbrook Batholith is conformable with the supracrustal rocks which it intrudes.

The contact zones are characterized by a narrow zone of pegmatite and by the presence of inclusions of supracrustal rock, within the pluton.

The bulk of the Northbrook Batholith consists of white to light grey and locally pink, medium- to coarse-grained lineated gneiss of granodiorite and trondhjemite compositions. At the contacts with the supracrustal rocks the rocks are medium to fine grained and foliated.

The coarse-grained light grey lineated biotite trondhjemite and granodiorite gneiss (map unit 6a) is limited to a few outcrops along the northern boundary of the area. The most common rock type within the Northbrook Batholith is a light grey to pink-grey medium-grained trondhjemite gneiss (map unit 6b) consisting essentially of oligoclase (55 to 60 percent), quartz (20 to 25 percent), microcline (2 to 8 percent), and biotite (10 to 20 percent). Smaller amounts of hornblende (3 to 5 percent) commonly accompany biotite. The biotite granodiorite gneisses containing 10 to 15 percent potassium feldspar are generally less common and occur in an area between Little Antoine and Cranberry Creeks. Grain-size of all felsic constituents is fairly homogeneous. Plagioclase is subidioblastic to xenoblastic, whereas quartz is only xenoblastic and commonly strongly strained. Recrystallization of large grains of quartz to small granoblastic grains is uncommon however some small granoblastic grains of quartz are present at the interstices of large quartz and plagioclase grains. Microcline forms small interstitial grains and myrmekite is commonly present at the contact of microcline with plagioclase. Common accessory minerals are apatite, sphene, and iron oxide. Minor secondary minerals comprise epidote, sericite, carbonate, and chlorite. The foliation is defined by the subparallel arrangement of biotite and less commonly by stretched grains of quartz. The trondhjemite gneiss of map unit 6c is distinguished from the gneiss of map unit 6b by a finer grained fabric and a well-developed foliation. Within map unit 6d are grouped darker grey medium-grained trondhjemite to diorite gneisses which contain 25 to 30 percent combined hornblende and biotite, smaller proportions of quartz, and little or no potassium feldspar.

Foliated gneisses occur in an approximately 1 km wide belt in the northwestern part of the map area and were included by Smith (1958) in the Lavant Gneiss (Addington Complex in this report). They are white to grey, generally medium grained and of trondhjemitic and granodioritic composition. Smith (1958) suggested that these rocks may be of metasedimentary origin. J.M. Ambrose and C.A. Burns (1956) reported that northeast of the Kaladar area the Addington gneiss and the Northbrook Batholith are 1 and the same rock unit. The author finds the bulk of these rocks texturally and compositionally similar to the gneisses occurring generally in the border zones of the Northbrook Batholith and therefore groups them with the Northbrook Batholith.

Pink gneiss of granodiorite and locally quartz monzonite composition occurs in a few places in this belt. The colour is caused by metasomatic alteration near large pegmatite bodies which intrude the Northbrook Batholith particularly along its border zones.

In the southwestern part of the region, blocks and slices (to 450 m wide) of Northbrook Batholith rocks are found within the Addington Complex and are considered to have been transposed by faulting.

Addington Complex

The Addington Complex (Lavant gneiss in 1958 report by Smith, Addington Pluton in 1979 and 1981 reports by Wolff) forms a narrow northeastward trending belt which extends from the vicinity of Actinolite, a village located 60 km southwest of the map area to the northeast beyond the northern limits of the map area for a total strike-length of about 85 km.

The Addington Complex is bordered by supracrustal rocks and by the Northbrook Batholith in the west and by supracrustal rocks in the east. The body is conformable with both the supracrustal rocks and with the Northbrook Batholith.

On average the body is about 4 km in width in the map area and forms a northeastward trending ridge from the southwestern part to the north-central part of the area.

The Robertson Lake Shear Zone extends along the eastern boundary of the complex and in the vicinity of the Snow Road Station the Addington Complex is affected by shearing. In many places it encloses conformable layers and lenses of supracrustal rocks (map unit 4) ranging in width from 1 m to 400 m, some of these layers are continuous along strike for up to 3 km. At the contacts of the body with the enclosed lithologies a narrow zone of potassium metasomatized host rocks is developed.

The Addington Complex is comprised of pink gneisses, which range in composition from quartz monzonite to granite. Unlike the bulk of the Northbrook Batholith, it is well foliated and somewhat compositionally and texturally layered.The most abundant rock type is fine-grained, pink leucocratic, weakly foliated gneiss ranging in composition from granite to quartz monzonite (map unit 7a). In thin section the rock consists of quartz (35 percent), microcline (30 to 40 percent), oligoclase (20 to 30 percent), and biotite (5 to 8 percent) with accessory iron oxide, zircon, and apatite. West of Gemmills Hill small grains of garnet were observed in the rock. The texture is commonly heteroblastic and the mineral grains range in size from 0.5 to 1 mm. Microcline is hypidioblastic.

Up to at least 3 km away from the Robertson Lake Shear Zone the rocks display effects of mechanical deformation. Quartz is strongly strained and commonly granulated to a very fine-grained mosaic that wraps around the porphyroclasts of plagioclase and microcline. Plagioclase is deformed to a lesser degree as evidenced by strained fractured grains and bent twin lamellae. Microcline appears to be less deformed. The foliation is defined by elongated grains of quartz and by the subparallel alignment of biotite.

In the field the map unit 7b is well distinguished from the unit 7a by a coarser texture (1 to 3 mm grain size) and a better developed foliation. Rocks of this unit consist of quartz (40 percent), oligoclase (25 percent), microcline (25 percent), biotite (7 percent), and hornblende (3 percent).

Fine-grained, well-foliated, pink granite, granodiorite, and quartz monzonite gneisses containing a larger proportion of biotite (15 to 25 percent) or biotite and hornblende comprise map unit 7c.

All of the above-described rock types are commonly interlayered and in many places occur in a single outcrop. The map unit 7b is the least abundant of the 3 map units.

The results of thin section examination and rock staining show that the most common rock types of the Addington Complex are quartz monzonite and granite gneiss with granodiorite gneiss being less common.

Four thin sectioned samples revealed that the gneisses possess heteroblastic non-equilibrium textures and exhibit effects of cataclastic deformation and replacement textures as evidenced by the replacement of plagioclase grains by microcline and quartz.

Early Tectonic to Syntectonic Mafic and Intermediate Intrusive Rocks

Dalhousie Amphibolite Complex

Situated in the southeastern part of the map area is a composite mafic to intermediate intrusive body, the Dalhousie Amphibolite Complex (map unit 8). The body is divided by bands of supracrustal rocks and by the younger Barbers Lake Intrusion into 3 separate segments. All the rocks with the exception of a pyroxenite mass north of Barbers Lake are recrystallized and more or less foliated. Poorly preserved, yet discernible megascopic textures reveal that this body, similar to the Lavant Gabbro Complex, originally was texturally and compositionally inhomogeneous. Only the pyroxenite mass north of Barbers Lake is homogeneous in both composition and texture.

The original rocks were comprised of granodiorite, quartz diorite, diorite, gabbro, anorthosite, and pyroxenite and all except the pyroxenite have been metamorphosed to a variety of gneiss and amphibolite. The intensity of deformation and the degree of recrystallization decreases from the southwest to the northeast. As evident from the map (back pocket) several textural and compositional varieties may be present within a single outcrop.

Map unit 8a comprises medium-grained (1 to 2 mm) quartz diorite gneiss. In the field these rocks are characterized by their pink colour. However, the thin-sectioned samples reveal that only a negligible amount of potassium feldspar is present and that the pink colour reflects the presence of finely dispersed hematite in plagioclase. In the thin section the rocks consist of an interlocking mosaic of plagioclase (50 to 60 percent), quartz (5 to 15 percent), and small amounts of microcline (0-2 percent). The mafic minerals represented by hornblende or hornblende and biotite comprise 30 to 40 percent of the rock. Secondary minerals include sericite, epidote, chlorite, actinolite, hematite, and leucoxene. Apatite and sphene are accessories. A well-developed foliation is defined by subparallel alignment of hornblende and biotite.

Map unit 8b is a light grey, medium-grained biotite - hornblende - quartz - plagioclase gneiss. The rock is well recrystallized consisting of equant grains of plagioclase (1 to 1.8 mm), smaller grains of quartz (0.50 mm), and small, irregular grains of microcline. Hornblende and biotite oriented in a subparallel manner define the foliation. The rocks contain variable amounts of quartz and microcline and range in composition from granodiorite to quartz diorite.

Fine-, medium-, and coarse-grained amphibolites which are very distinct containing pink to violet plagioclase, are assigned to unit 8c.

Locally narrow discordant dikes and veinlets of fine- to medium-grained, white to light grey granodiorite gneiss or pink biotite granite gneiss cut through the body (map unit 8d).

Diorite gneiss (map unit 8e) is medium to fine grained and typically of greyish green colour. It is distinguished from more mafic amphibolite by the larger proportion of felsic minerals and the presence of ubiquitous biotite. The rocks are composed of relict and granoblastic plagioclase (60 percent), subidioblastic grains and aggregates of hornblende (20 percent), small flakes of biotite (15 percent), and less than 5 percent quartz. Relict plagioclase forms up to 4 mm long laths. Foliation is defined by discontinuous elongated aggregates of hornblende, subparallel flakes of biotite and also by relict laths of plagioclase.

A substantial part of the Dalhousie Amphibolite Complex is comprised of gabbroic rocks that have been transformed to a variety of amphibolites.The amphibolites range in grain size from fine, medium, to coarse grained (map units 8f, g, h, j). In outcrop, the colour of the rock types varies from dark green in fine-grained varieties to green and white mottled in medium- and coarse-grained amphibolites. The rocks are composed of plagioclase (50 to 60 percent) and hornblende (50 to 40 percent). Plagioclase forms a granoblastic to granoblastic-polygonal interlocking mosaic; hornblende forms either aggregates of small subparallel grains or larger idioblastic to subidioblastic grains. Scapolite commonly accompanies plagioclase in the mosaic. Common accessory minerals are sphene, iron oxide, and apatite. Some amphibolites contain up to 10 percent biotite in

Photo 2. *The coarse-grained ophitic texture is well preserved in the eastern, less deformed part of the Dalhousie Amphibolite Complex. Photo also illustrates a presence of 2 phases of gabbro and their non-gradational contact which are typical characteristics of mafic to intermediate plutonic rocks in the Dalhousie Lake area. 2 km south of Barbers Lake.*

addition to hornblende. Relict textures were observed in several thin sections. They are represented primarily by long laths of plagioclase. The laths are up to 4 mm long in medium-grained and up to 15 mm long in coarse-grained amphibolites. The relict plagioclase laths are strongly strained to fractured with commonly bent twin lamellae. The edges and parts of the original plagioclase laths show replacement by granoblastic plagioclase. Primary, relict plagioclase are Ca-rich andesine to labradorite; recrystallized plagioclase is andesine. Poorly preserved subophitic textures were observed in 2 thin sections. Relict hypersthene is uncommon and was observed in only 1 sample where it occurred with primary, large (3.5 mm) plagioclase laths suggesting that the rock was originally norite. The southwestern segment of the Dalhousie Amphibolite Complex generally displays a higher degree of recrystallization and fabric orientation and west of Crains Lake, some parts of the amphibolite mass show complete recrystallization accompanied by segregation of mafic and felsic phases and development of a strong planar-linear fabric. On relatively less deformed parts of the complex, particularly in the middle and northeastern segments, discontinuous lenticular foliations prevail. The texture ranges from nonequilibrium granoblastic texture containing sutured grain boundaries and relict minerals to granoblastic-polygonal equilibrium textures. In the eastern part of the middle segment, very coarse grained to pegmatitic amphibolites with a relict ophitic texture were observed (map unit 8j) (Photo 2). This unit strongly resembles the coarse-grained gabbro (map unit 9j) of the Lavant Gabbro Complex. The conformable to discordant layers and patches of fine- to medium-grained hornblende + magnetite and hornblende-biotite ±magnetite schist accompany amphibolite throughout the southwestern and middle segments (map unit 8k).

White to light grey medium-grained gneisses (map unit 8m) containing up to 80 percent plagioclase are confined particularly to the southwestern segment of the Dalhousie Amphibolite Complex and smaller amounts also occur in the eastern part of the middle segment. These rocks are homeoblastic consisting essentially of an

interlocking mosaic of well-bounded small (0.50 to 0.70 mm) grains of plagioclase. Small amounts of scapolite, hornblende, and biotite accompany the plagioclase mosaic. Hornblende forms larger (1 to 1.3 mm) subidioblastic grains or may accumulate as clusters of small grains. Hornblende and biotite comprise 20 to 30 percent of the rock with hornblende being predominant. Long laths (up to 3.5 mm) of relict plagioclase are present in less deformed specimens. The foliation is defined by discontinuous subparallel layers of mafic minerals. West of Crains Lake completely recrystallized strongly lineated anorthositic gneisses containing no relict textures are present together with strongly deformed amphibolites.

Most of the minerals in the amphibolite and anorthositic gneiss are relatively unaltered. Minor secondary alterations to sericite and saussurite have sporadically developed in relict as well as in recrystallized plagioclase. Small colourless to pale green grains of secondary pumpellyite were seen in plagioclase in 2 different outcrops.

North of Barbers Lake pyroxenite underlies an area of about 2.5 km^2. In the south and the west, the pyroxenite (map unit 8p) is enveloped by a narrow zone of less deformed amphibolite and coarse-grained pyroxene gabbro-amphibolite (map unit 8s).

Pyroxenite is dark grey-green, medium to coarse grained with grain sizes ranging from 3.5 to 6 mm. In thin section the rock consists of nonoriented tabular grains of clinopyroxene (75 percent) and corroded, oval-shaped to irregular grains of completely serpentinized olivine (25 percent). A network of serpentine-filled contraction cracks radiates from olivine into surrounding pyroxene. The pyroxene grains are colourless and their extinction angle is about 36 to 40 degrees indicating diopside composition. Large pyroxene grains are partly altered to hornblende. The alteration is somewhat selective and the alteration patterns suggests that the altered parts of pyroxene were originally a different type of pyroxene (likely orthopyroxene) which were intergrown with or exsolved in clinopyroxene. Some pyroxene grains are stippled with fine grains and needles of secondary iron oxide. Some carbonate and iron oxide accompany pseudomorphs of serpentine. Several small bodies of more altered pyroxenite are also present along the north shore of Crains Lake in the southwestern segment and in the southwestern part of the middle segment of the amphibolite complex.

Locally the Dalhousie Amphibolite Complex is cut by up to 50 cm thick dikes of green, medium-grained pyroxenite (map unit 8n). The dikes are strongly altered to hornblende and actinolite and only small relict grains of original clinopyroxene are preserved. In contrast to the Lavant Gabbro Complex described below the Dalhousie Amphibolite Complex appears to be a well-differentiated body containing pyroxenite, gabbro, norite, anorthositic gabbro, anorthosite, diorite, and quartz diorite. Diorite and quartz diorite phases occur only locally. Inclusions of roof pendants and fine-grained gabbroic phases are scarce. Thus the Dalhousie Amphibolite Complex may be viewed as a deeper level intrusion and its relation to the Lavant Gabbro Complex is uncertain.

Lavant Gabbro Complex

The central part of the map area is underlain by the northeastward trending Lavant Gabbro Complex (Lavant gabbro in 1958 report by Smith; Lavant mafic Intrusion in 1981 report by Wolff). The intrusion extends for about 21 km northeastward beyond the area boundary to Lavant and Darling Townships and about 3.2 km southwestward beyond the southern limits of the area reaching a total length of about 49 km. The width of the body within the region is 5.5 to 8 km and it increases in the northeast, particularly beyond the north boundary (Smith 1958). The body trends northeastward (N30E), parallel to the strike of the supracrustal rocks which it intrudes, and is bounded by a thick horizon of marbles in the east and by metavolcanics and metasediments in the west. Small intrusions of Lavant Gabbro Complex rocks pierce the supracrustal rocks near the main intrusion.

The southwestern margin of this complex lies within the Robertson Lake Shear Zone. The Lavant Gabbro Complex comprises rocks of granodiorite, quartz diorite, diorite, gabbro-diorite, quartz gabbro, and gabbro compositions. In addition aplite,

granite, syenite, and a diabase dike are in this complex. Although the body shows a northeastward structural trend, the rocks themselves are structureless.

Invariably, patches of several compositional and textural varieties showing no gradational contacts are found within a single outcrop. The Lavant Gabbro Complex incorporates narrow bands of marble and inclusions of foliated mafic gneiss and schist (map unit 9k) which probably represent roof pendants. The compositional and textural characteristics suggest that several subsequent intrusive stages are responsible for the heterogeneity of this body. In the southern and northeastern parts of the complex, rocks of diorite and granodiorite compositions are dominant whereas in the northern and the northwestern parts of the complex rocks of gabbroic and gabbro-dioritic compositions prevail. Within the map area the average composition of the Lavant Gabbro Complex is more intermediate than mafic. Although widespread, the pink granite-pegmatite (map unit 9a) and white aplite (map unit 9b) dikes and veins are the least voluminous rock types. Map unit 9c occurs in an area underlain by the Lavant Gabbro Complex near the Elphin Intrusion. It represents a pink, medium-grained granite and syenite contaminated with inclusions of rocks of the Lavant Gabbro Complex. These rocks are possibly associated with the Elphin Intrusion and some larger, mappable, more less contaminated offshoots of the Elphin Intrusion occur within the southeastern part of the Lavant Gabbro Complex.

The map unit 9d comprises hybrid phases which are composed of a mixture of gabbroic to granitic rocks which were generated during the intrusion of the Elphin Intrusion. These rocks are similar to the above described rocks of map unit 9c although a difference lies in a degree of mixing and homogenization whereby hybrids generally are more mafic than the contaminated granites of map unit 9c.

The other rocks of the map unit 9 described below belong to the Lavant Gabbro Complex proper.

Quartz diorite and granodiorite (map unit 9e) form dikes and small discordant bodies that cut through the mafic and intermediate rocks of the Lavant Gabbro Complex. They are abundant particularly in the southern parts of the complex where together with diorite (map unit 9f) they are more abundant than the mafic rocks. Their contacts with the older phases of the complex are sharp. The quartz diorite and granodiorite weather white-grey to light grey and are commonly medium (1 to 3 mm), locally fine, or coarse grained.

Four thin sections were studied. The dominant minerals are oligoclase (45 to 60 percent), quartz (20 to 45 percent)and biotite, or biotite and hornblende (10 to 20 percent). Muscovite, microcline, apatite, sphene, and iron oxide comprise minor phases. Stained samples revealed that granodiorite is also present. Plagioclase grains are subhedral, equidimensional to lath-shaped, whereas quartz grains are irregular, strongly strained, and in places replaced by granoblastic quartz. Some effects of deformation such as granulations, sutured grain boundaries, and replacements along the edges by granoblastic quartz are evident also in plagioclase.

The most abundant member of the Lavant Gabbro Complex is map unit 9f represented by green-grey most commonly medium-grained diorite and gabbro-diorite. Subhedral grains of plagioclase constitute 45 to 60 percent of the rock. Up to 10 percent of interstitial, strongly strained to granoblastic quartz may be present. Irregular nonoriented grains of hornblende which do not display a preferred orientation are commonly accompanied by small amounts of biotite. Together these 2 minerals make up 30 to 40 percent of the rock. Common accessory minerals are apatite, iron oxide, and sulphide minerals. A variety of secondary minerals including sericite, scapolite, chlorite, and, in 1 thin section, secondary pumpellyite were identified. Pumpellyite forms green pleochroic radiating aggregates and together with chlorite replaces biotite.

Medium- to coarse-grained rocks of gabbroic composition (Map unit 9g) are particularly common along the western border and in the western and the northwestern parts of the body. The rocks are massive, dark green in colour, and possess a colour index greater than 40. The textures in hand specimen and thin section vary in grain size from 1 to 6 mm and are equigranular hypidiomorphic

granular to ophitic. In the thin section the rocks are composed of subhedral to anhedral laths of andesine and of irregular grains to aggregates of hornblende. Pseudomorphs of hornblende after pyroxene are commonly present and small relict grains of pyroxene were noted in 2 thin sections. Up to 5 percent of interstitial quartz and up to 10 percent of biotite may be present. Minor minerals are sphene, iron oxide, and apatite. The intensity of secondary alteration varies from place to place. Plagioclase is commonly altered to sericite, carbonate, scapolite, and saussurite. Hornblende and biotite show alteration to chlorite and carbonate.

Very coarse grained gabbro (0.50 to 20 mm) composed of large laths of plagioclase, long prisms of hornblende, and aggregates of hornblende with well-developed ophitic to subophitic textures forms *schlieren* in fine-grained gabbro in the northwestern parts of the Lavant Gabbro Complex.

Map unit 9h is widely distributed throughout the Lavant Gabbro Complex and is a common constituent of nearly every outcrop. It is represented by fine to very fine, dark green to dark grey-green massive rocks which range in composition from diorite to gabbro.

In thin sections, these rocks are more or less equigranular and consist of subhedral to anhedral zoned plagioclase (45 to 50 percent) and anhedral hornblende (35 to 50 percent). Biotite makes up to 8 percent, and iron oxide up to 5 percent of the rocks. Minor sulphide minerals also occur. Most plagioclase is primary; some is recrystallized. Hornblende and biotite display poor fabric alignment. Three thin sections studied were of gabbroic composition, however, lighter coloured, dioritic rocks carrying mainly biotite were recognized in the field.

Fine to very fine grained, dark green foliated rocks occur within the Lavant Gabbro Complex (map unit 9k). They are believed to represent roof pendants and are up to 1.5 by 5 m in size. The rocks are foliated parallel to the regional trend of the surrounding supracrustal rocks. In thin section they are completely recrystallized, granoblastic, and resemble metavolcanics of map unit 1a. They consist of fine granoblastic plagioclase and scapolite, idioblastic to subidioblastic hornblende, and small granules of epidote. Subparallel alignment of the long axis of hornblende together with the segregated layers of hornblende and epidote define the foliation. Sphene and apatite are accessory minerals.

Rocks of map unit 9 m are strongly deformed, mylonitized Lavant Gabbro Complex rocks in the southwestern part of the map area which lie within the Robertson Lake Shear Zone. They are strongly fractured and sheared. Fractures are filled with epidote, carbonate, chlorite, and commonly pyrite. In thin section the rocks display mortar texture consisting of very fine granulated quartz, chlorite, and epidote. Pyrite and tourmaline are present as small porphyroblasts. Thin sections show that not only carbonatization but also silicification took place.

Two small dikes of the fine-grained, dark green, massive gabbro (map unit 9 n) penetrate the marble horizon in the vicinity of Pratt Corners in the southeastern part of the map area. In turn these dikes are intruded by numerous veinlets and dikes of fine-grained granite which resembles the Barbers Lake Intrusion with which it is probably associated.

A narrow (300 m wide and 3.2 km long) conformable band of the mafic gneisses which resemble the Lavant Gabbro Complex, is present within the Addington Complex north of Snow Road Station. The band is comprised of granodiorite, medium- to coarse-grained gabbro, and fine-grained gabbro and diorite. The rocks are completely recrystallized and foliated parallel to the host rock foliation. They appear to have been a part of the Lavant Gabbro Complex that was tectonically separated from the main body. Smith (1958) considered the Lavant Gabbro Complex possibly to be younger than both the Addington Complex and the Northbrook Batholith.

As mentioned above the Lavant Gabbro Complex is composed of pods, patches, and dikes of various gabbroic and dioritic rocks. Its emplacement history can be described as follows. The initial magmatic phase cooled slowly giving rise to medium-, coarse-grained to pegmatitic gabbroic rocks. These rocks subsequently were fractured. Along fractures a second melt of similar or more felsic

composition, intruded and quickly solidified. This second magmatic pulse was followed by another fracturing event and by a series of dioritic and granodioritic injections, which probably represent later differentiates of a deep-seated melt. Finally aplitic-granodioritic and granitic-pegmatitic dikes and veins were emplaced.

Common presence of the roof pendants and a lack of more mafic differentiates suggest that the Lavant Gabbro Complex is a rather high-level intrusion and unrelated to the Dalhousie Amphibolite Complex.

There are also remarkable differences in the degree of deformation and recrystallization between the Lavant Gabbro Complex and the Dalhousie Amphibolite Complex. This factor however should not be over-emphasized since the difference in size of the bodies and "cushioning" of the Lavant Gabbro Complex by incompetent marble might have played a role in their different response to deformation and metamorphism.

FLINTON GROUP

Bishop Corners Formation

A narrow (100 to 300 m wide) band of Flinton Group metaconglomerate overlies the older metavolcanics and metasediments in the southwestern part of the map area. It extends beyond the western boundary where it has been documented to occupy a synformal-antiformal structure (Pauk 1982b). The conglomerate was transposed into a conformable position within the metavolcanics and metasediments by at least 2 episodes of post-Flinton deformation. The band exposed along the western boundary lies on the southern limb of the above-mentioned antiform. The conglomerate has been strongly deformed and metamorphosed and its conglomeratic texture is poorly preserved.

Two major types of conglomerate are in the map area. The first type strongly resembles coarse-grained, coarsely banded leucocratic gneiss. Clasts are not easily recognized because of strong deformation and the rock consists of about 2 cm thick layers of coarse-grained quartzite which alternates with coarse, about 2 cm thick bands of granitic composition (quartz and microcline). A third type of layer is narrower (0.5 cm), discontinuous, and less repetitive. It is comprised of medium-grained quartz, plagioclase, biotite, and muscovite and probably represents deformed clasts. The coarse-grained quartzose layers are of distinct bluish grey colour and are composed primarily of large (5 mm), xenoblastic, strongly strained, and subparallel elongated grains of quartz. Small, well-aligned muscovite and biotite form inclusions within quartz. The quartz-potassium feldspar layers are pink, medium-grained, and display a common granitic texture. They consist basically of quartz and microcline. The quartz-microcline layers in places are continuous along strike for up to several metres but more commonly pinch and swell over intervals of 0.30 to 1 m. Although found in several locations within the map area this type of conglomerate is confined mainly to the synform west of the map area. The author believes that the quartz-potassium feldspar bands which possess a granitic-pegmatitic texture have been injected or regenerated from the original arkosic layers and interprets the rock as migmatized metaconglomerate (Photo 3).

The second type of conglomerate present consists of strongly deformed stretched clasts of quartzite, fine- to medium-grained pink biotite granite (up to 20 cm in size), and smaller clasts of mafic composition. Granite clasts differ from the above-described quartz-microcline layers by their finer grain size, larger proportion of biotite, and by a foliated fabric. The clasts are set in a foliated coarse crystalline, quartz-rich matrix with only small amounts of biotite, muscovite, microcline, and plagioclase. Where conglomerate overlies the older metavolcanics, the proportion of mafic clasts increases and the quartzose matrix is enriched with a variety of mafic and other minerals which include hornblende, diopside, epidote, scapolite, carbonate, and sphene. The mafic clasts are commonly deformed to such a degree that the distinction between matrix and clasts becomes difficult. This second type of conglomerate extends to south of the area into Oso Township where its conglomeratic texture is better preserved. The conglomerate is intruded by large pegmatite bodies which limit the surface exposure of the conglomerate.

Photo 3. *Strongly deformed and migmatized metaconglomerate of the Flinton Group exposed in the extreme southwestern part of the map area.*

LATE INTRUSIVE ROCKS

The late tectonic intrusions of predominantly granite composition include small bodies of the Elphin Intrusion and the Barbers Lake Intrusion in the central and southeastern parts of the region and numerous pegmatite dikes and sills throughout the map area.

Late Tectonic Felsic Intrusive Rocks

Elphin Intrusion

A lens-shaped body, the Elphin Intrusion covering an area of about 20 km^2 intrudes the Lavant Gabbro Complex in the vicinity of the village of Elphin in the central part of the region. It comprises unfoliated medium-grained pink biotite granite, and minor syenite. The boundaries between the Lavant Gabbro Complex and the Elphin Intrusion are gradational through a wide zone of gabbro-diorite rocks containing granite-monzonite veins and through hybrid phases particularly along the southern border of the body. Boundaries to the lens-shaped body were drawn where, proportionally, granite-monzonite veins are more common than the rocks of the Lavant Gabbro. Therefore a large number of hybrid rocks and inclusions of the Lavant Gabbro Complex are incorporated within the Elphin Intrusion as outlined on the map that accompanies the present report (back pocket).

Map unit 11a includes gabbro-diorite rocks of the Lavant Gabbro Complex intruded by biotite granite veins, and occurs at the margins of the Elphin Intrusion, mainly in the northwestern part and less commonly in the interior of the body.

Large parts of the intrusion particularly near Wilson Hill and the village of Elphin, are composed of hybrid phases (map unit 11b). The hybrid phases are coarse-grained suggesting slow cooling. Locally porphyritic hybrid rocks containing large (1 cm) phenocrysts of orthoclase were encountered. Mineral composition of the hybrid phases is rather similar to, yet overall more felsic than, that of the Lavant Gabbro Complex.

The map unit 11c includes rocks of the Elphin Intrusion proper. The dominant rock type is a medium-grained pink biotite granite. In thin section the rock consists of anhedral microcline (40 to 45 percent), anhedral oligoclase (18 to 25 percent), and about 20 percent of interstitial quartz. Biotite comprising 12 to 15 percent of the rock is the major mafic mineral. Accessory minerals are iron oxide, sulphide minerals, sphene, and muscovite. Plagioclase is partly altered to sericite, scapolite, or saussurite. Partial recrystallization of quartz and microcline to a granoblastic mosaic was also encountered in one of the three thin sections studied. The granitic rocks display a heterogeneous, allotriomorphic granular, non-foliated fabric. Most granitic rocks are granites proper. Minor biotite monzonite to syenite also occurs.

Small offshoots of the Elphin Intrusion are present within the southeastern part of the Lavant Gabbro Complex.

The body is elongated parallel to the northeastern regional structural trend, yet the rocks show a total lack of foliation. The intrusion was emplaced probably after the culmination of deformation and further it might have been cushioned against deformation by the Lavant Gabbro Complex.

Barbers Lake Intrusion

The Barbers Lake felsic intrusion situated in the southeastern part of the map area is an intrusion into supracrustal rocks and into the Dalhousie Amphibolite Complex. The main body is roughly circular in plan and covers an area of about 10 km^2. It is fairly uniform in composition and texture consisting of medium-grained, non-foliated, pink leucocratic biotite-muscovite granite. Associated with the main body are narrow sheets of rather finer grained granite which intrude the supracrustal rocks and the Dalhousie Amphibolite Complex along the foliation planes of these rocks. The bulk of the body is only poorly exposed in swampy depressions and except for its southern part the contacts with the host rocks are poorly exposed. The crosscutting relationship with the Dalhousie Amphibolite Complex is well exposed in the southern parts of the intrusion. Granite (map unit 12a) is uniformly medium grained (1 to 2.5 mm) and displays an essentially hypidiomorphic-granular texture. The mode is fairly uniform being typically microcline (40 percent), quartz (30 percent), oligoclase (20 percent), biotite and muscovite (8 percent), and hematized iron oxide (1 percent) with accessory apatite, tourmaline, and fluorite. Minerals of the pyrochlore group were recorded by K. Ford (Geological Survey of Canada, Resource Geophysics and Geochemistry Division, Ottawa, personal communication, 1981). The associated granite sills (map unit 12b) are usually finer grained (0.75 to 1 mm), containing more quartz at the expense of plagioclase and all minerals have xenomorphic form thus resembling an aplitic texture. The Barbers Lake Intrusion is viewed by the author as the youngest posttectonic larger scale intrusion within the map area, and is considered to be unrelated to the Elphin Intrusion. K. Ford (Geological Survey of Canada, Resource Geophysics and Geochemistry, Ottawa, personal communication, 1981) studied the trace element geochemistry of the Barbers Lake and the Elphin Intrusions. His observations show that the Barbers Lake Intrusion compared with the Elphin Intrusion carries a higher amount of uranium, thorium, and niobium.

Pegmatite Dikes and Sills

Pink and white pegmatite dikes and sills are widely distributed throughout the map area. White pegmatites occurring mostly in the form of sills are preferentially spatially associated with the supracrustal rocks whereas pink pegmatites forming both dikes and sills are spatially confined to intrusive bodies.

The pegmatite dikes and sills display sharp contacts with the country rock and cut across the foliation of the host rock or intrude parallel to the foliation of the host rock. Locally, blocks or pieces of country rock are enclosed or almost completely assimilated by pegmatites. The pegmatites also crosscut each other indicating that they were emplaced at least 2 different times. Some strongly deformed pegmatite sills showing cataclastic and sheared textures are present in the southwestern part of the map area. These deformed pegmatites carry the best uranium values. Pink pegmatite dikes and swarms (map unit 13b) intrude the

Northbrook Batholith, the Addington Complex, and to a lesser extent the Lavant Gabbro Complex (map unit 9a). Bodies of pink pegmatite sills (map unit 13a) occur mainly in the Addington Complex, the Northbrook Batholith, and less commonly in the supracrustal rocks.

White pegmatites occurring mostly as sills (map unit 13c) intrude conformably along the foliation of the supracrustal rocks in all parts of the map area and particularly in the western belt of the supracrustal rocks, in the slices of supracrustal rocks within the Addington Complex, and in the Flinton Group metaconglomerate. Uranium mineralization is associated with the white pegmatites occurring in the southwestern and west-central parts of the region. White pegmatite dikes (map unit 13d) are generally less common than white pegmatite sills. Both white and pink pegmatite sills may form large bodies, up to approximately 200 m wide, and may be continuous along strike for about 600 m.

The pegmatites vary greatly in grain size, however, very coarse-grained pegmatites are not present, and pegmatites with graphic texture are uncommon.

The essential felsic minerals of pink to flesh coloured pegmatites are microcline-perthite, quartz, and small amounts of albite. Common mafic phases are biotite and some hornblende. A common accessory mineral is magnetite. White pegmatites are composed either of albite and quartz, or white microcline, quartz and smaller amounts of albite. Biotite is the major mafic constituent and some white pegmatites carry tourmaline.

Phanerozoic

CENOZOIC

QUATERNARY

Pleistocene and Recent

Unconsolidated deposits of sand, gravel, and till have been deposited during the Pleistocene in glacial and post-glacial lakes and river channels. Narrow but continuous glaciofluvial deposits forming a system of southwestward trending eskers occupy the depression of the Robertson Lake Shear Zone. E.P. Henderson 21973) described these deposits as ice-contact stratified drift. Sand, gravel, and minor till occur in eskers, kames, and kame moraines. Glacial striae recorded by Henderson (1973) in this area indicate a southwestward ice movement. Accumulations of sand, gravel, and sandy till deposited by glaciofluvial and by ground moraine action also occur north of Barbers Lake where many swamps are encountered. This zone of Pleistocene and Recent deposits extends southwestward to Gordons Hill where it turns to the south along the Pauls Creek. Small, isolated kames and eskers are widespread throughout the map area.

Recent deposits include organic swamps and alluvial deposits. The largest swamps occupy areas underlain by marble. Narrow swamps paralleling the regional strike are formed at the contacts of resistant and less resistant lithological units; thus bands of supracrustal rocks lie in the swampy depressions whereas plutonic rocks form ridges. The fault zones and in particular their intersections are occupied by the swampy depressions and stream beds.

Metamorphism

All rocks in the map area were subjected to metamorphism during the Late Precambrian.

Structurally the area can be subdivided into a western and an eastern zone. In both zones the metamorphic grade is the same. However, the zones possess different characteristics with respect to the time of the emplacement of the intrusive bodies. These characteristics will be dealt with separately with regard to the metamorphism.

WESTERN STRUCTURAL ZONE

During the regional metamorphism the supracrustal rocks have responded most readily to pressure and temperature and have been completely recrystallized to a variety of well-foliated gneisses and schists. The observed metamorphic mineral assemblages in the siliceous clastic, calcareous clastic, and carbonate metasediments and metavolcanics (Table 2) are indicative of the almandine - amphibolite facies of regional metamorphism. The metavolcanics carry mineral assemblages of hornblende-plagioclase (An_{36-56}) ±garnet and biotite - hornblende - plagioclase (An_{30}) ±quartz throughout the whole western structural zone. The absence of epidote and hypersthene in the metavolcanics further indicates that the rocks were subjected to the upper almandine-amphibolite facies metamorphic conditions (Winkler 1965).

The northeastward-increasing metamorphic grade has been documented in the pelitic schists of the Flinton Group west and southwest of the map area (Moore and Thompson 1972; Sethuraman and Moore 1973; Rivers 1976; Pauk 1982a) and generally within the Hastings Basin (Lumbers 1967; Moore and Morton 1980). It is not possible to show a similar zoning of the metamorphic grade within the map region because pelitic rocks with their diagnostic mineral assemblages are absent. High pressure-temperature conditions led to anatexis (Winkler 1967) in the area. The Addington Complex and the migmatization of the conglomerates are believed to be of anatectic origin.

The Northbrook Batholith appears to be a metamorphosed intrusive body. An eastward increasing metamorphic grade in the Northbrook Batholith has been reported by Chapman-Kamilli (1974). She recorded that the amount of biotite, muscovite, and epidote decreases and that the amount of hornblende concomitantly increases toward the northeast. Narrow bands of metavolcanics and marginal zones of the thicker bands of metavolcanics enclosed by the Northbrook Batholith are generally coarser grained as they were affected by both contact and regional metamorphism.

EASTERN STRUCTURAL ZONE

The rock sequence exposed east of the Robertson Lake Shear Zone forms part of the frontier of the Frontenac Axis. The increase in metamorphic grade from the Robertson Lake Shear Zone to the southeast was recorded by Wolff (1981) just south of the map region.

Within the map area the supracrustal rocks are represented by fairly uniform carbonate metasediments with only narrow layers of metavolcanics and calcareous clastic metasediments. The mineral assemblage of the metavolcanics is uniformly hornblende-plagioclase with no albite, epidote, or hypersthene. It is thus compatible with the upper almandine-amphibolite facies similar to the metavolcanics within the western part of the region. A larger part of this structural zone is occupied by intrusive bodies. The Lavant Gabbro Complex is believed to have been emplaced as several subsequent mafic and intermediate to felsic injections over a longer period of time. Except for minor crystalloblastic plagioclase and retrograde transformation of pyroxene to hornblende in some gabbro phases, these rocks do not show signs of strong deformation and metamorphism. Negligible recrystallization and deformation can be observed in the Elphin Intrusion which intrudes the Lavant Gabbro Complex in the vicinity of the village of Elphin.

TABLE 2. METAMORPHIC MINERAL ASSEMBLAGES IN THE SUPRACRUSTAL ROCKS OF THE WESTERN STRUCTURAL ZONE OF THE DALHOUSIE LAKE AREA.

Rock Group	Assemblage
Siliceous clastic metasediments	Plagioclase-quartz-biotite ± muscovite ± microcline muscovite ± microcline
Calc-silicate clastic metasediments	Plagioclase-quartz-scapolite-diopside-calcite-epidote or clinozoisite ± tremolite ± microcline
Calc-silicate clastic metasediments	Plagioclase-quartz-scapolite-diopside ± tremolite ± microcline
Carbonate metasediments	Calcite ± diopside ± tremolite ± phlogopite
Mafic metavolcanics	Plagioclase-hornblende ± garnet
Intermediate metavolcanics	Plagioclase-hornblende-biotite ± quartz

The Dalhousie Amphibolite Complex is a smaller intrusive body of ultramafic to intermediate composition. Unlike the Lavant Gabbro Complex, it has been partially to fully recrystallized to a variety of gneisses, schists, and amphibolites. Several factors such as: the difference in size of the bodies, the difference in time of the emplacement of the bodies, and the effects of thermal metamorphism are responsible for remarkable differences in the degree of deformation and recrystallization between the Lavant Gabbro Complex and the Dalhousie Amphibolite Complex.

Gabbroic rocks of the Dalhousie Amphibolite Complex have been metamorphosed to granoblastic, fine- to medium-grained amphibolites. The southwestern segment of the complex has been the most recrystallized and deformed and some parts of this segment have developed a strong planar-linear fabric. The degree of deformation and recrystallization within the Dalhousie Amphibolite Complex decreases toward the central and northeast segments where numerous relict laths of plagioclase, relict clinopyroxene, and orthopyroxene are present. The retrograde transformation of the original orthopyroxene to hornblende indicates that neither part of the map region has reached the stability field of hypersthene. The mass of pyroxenite exposed north of Barbers Lake has been the least deformed and recrystallized. The interior of the pyroxenite mass displays igneous textures and carries the original diopside, whereas the original olivine and orthopyroxene have been altered to serpentine and hornblende respectively. The central part of the Dalhousie Amphibolite Complex has been intruded by the late stage Barbers Lake Intrusion which is unmetamorphosed and undeformed. The contact metamorphism caused by the Barbers Lake Intrusion, and regional metamorphism are believed to be responsible for the recrystallization and deformation of the Dalhousie Amphibolite Complex.

The rocks lying within the Robertson Lake Shear Zone have been subjected to strong cataclastic deformation, shearing, and associated retrograde alteration. Elsewhere in the map area the effects of the retrograde metamorphism are documented by sericitization and saussuritization of plagioclase and chloritization and epidotization of biotite and hornblende. It is noteworthy that minor pumpellyite has also been identified as an alteration product of biotite and plagioclase in the mafic to intermediate rocks of the Lavant Gabbro Complex, the Dalhousie Amphibolite Complex, and in hybrid phases of the Elphin Intrusion.

Structural Geology

REGIONAL SETTING

The map area includes part of the Central Metasedimentary Belt (Wynne-Edwards 1972) of the Grenville Province. Structurally, the region is divided by the major, approximately northeastward striking, Robertson Lake Shear Zone into a western and a eastern structural zone. The western structural zone forms a part of the Hastings Basin, that is the segment IV.b of the Central Metasedimentary Belt, whereas the eastern structural zone represents the frontier of the Frontenac Axis, that is the segment IV.c of the Central Metasedimentary Belt (Wynne-Edwards 1972). The western structural zone is comprised of northeastward trending belts of the supracrustal rocks, minor Flinton Group rocks, and of the syntectonic felsic plutonic masses which all have been deformed.

The area east of the Robertson Lake Shear Zone straddles the boundary of the Hastings Basin and the Frontenac Axis. Geology and structure of this area are dominated by a number of early to late tectonic mafic to felsic intrusive bodies. The supracrustal rocks are comprised of a fairly compositionally and structurally uniform unit of marble with only narrow isolated layers of metavolcanics and clastic metasediments. The northeastward striking structural trends are also dominant in this structural zone.

Both structural zones have been deformed by at least 2 phases of the post-Flinton deformation. Within the map area the distinct difference in the patterns of deformation of these 2 structural zones, as described below is essentially a function of the mechanical properties of the supracrustal rocks and possibly the difference in the time of the emplacement of the intrusive bodies.

FOLDS

WESTERN STRUCTURAL ZONE

The supracrustal rocks, the Flinton Group rocks and most of the plutonic rocks (with the exception of the late stage pegmatites) in this structural zone have been subjected to at least 2 major phases of post-Flinton deformation.

The metasediments and metavolcanics have been isoclinally folded (D_1) into northeastward (N20E to N40E) trending zones. Associated axial planar foliation is penetrative and parallel to nearly parallel to the bedding surfaces and dips uniformly to the south in most parts of the map area. The isoclinal folding in these rocks is expressed by the frequent repetition of the lithologies within these supracrustal units. This type of folding is well documented in the road-cuts of Highway 509 southeast of the village of Donaldson (Photo 4). Foliation-gneissosity in the plutonic rocks, the Addington Complex, and the Northbrook Batholith is concordant and continuous with the foliation in the surrounding supracrustal rocks which suggests, that both the plutonic and supracrustal rocks have a similar tectonic history. The second phase of deformation (D_2) generated large northeastward trending megascopic structures. Most of these structures occupy the area just along the western limits of the area and only small parts extend into the map area. The northwestern part of the region contains part of the closure and part of the southern limb of the D_2 Cross Lake Antiform. This structure is documented on the Preliminary Map P. 2478 of the Ardoch Area (Pauk 1982a) discussed in the report on the Ardoch Area (Pauk 1982b). A brief description of this structure is given below.

The Northbrook Batholith (map unit 6) intruded the metavolcanics in a series of sheets. Subsequent deformation gave rise to an elongate domal antiform. Granodiorite gneiss forms the core of this dome, the supracrustal rocks the deformed flanks. This large regional structure extends from the Marble Lake area (30 km southwest of the map area) northeastward for about 30 km and exhibits a shallow double plunge. Around its northeast closure within the map area it plunges 25 degrees northeast. In the hinge area supracrustal rocks exhibit refolded D_1 isoclinal folds.

The southwestern part of the map area is underlain by a number of lithologies including the Northbrook Batholith, metasediments, and metavolcanics. These units

Photo 4. *Refolded isoclines in clastic and carbonate metasediments are exposed in the hinge of the Cross Lake Antiform in the road-cut along Highway 509 in the northwestern part of the map area.*

are overlain by the metaconglomerate of the Flinton Group. The whole sequence has been folded by 2 phases of deformation and the metaconglomerate of the Flinton Group was infolded into the older supracrustal rocks. The second phase of deformation generated synformal and antiformal structures. These structures are poorly exposed along the western boundary of the map area, where only the southern limb of the antiform is present (map units, 1, 6, 10). The adjacent region to the west of the map area was mapped by the author in 1980 (Pauk 1982b).

The synformal and antiformal structures described above are defined by the outcrop pattern of the metavolcanics and by the Flinton Group. Both structures are trending northeastward (N45E and N35E respectively) and plunge about 25 degrees to the northeast. Their axial plane foliations dip moderately (25 to 50 degrees) to the southeast. The core of the antiform is occupied by the Flinton Group which exhibits S_1 and S_2 foliations which cut each other at approximately 50 degrees. The foliation S_1 is defined by up to 2 cm thick gneissic bands and by flattened stretched clasts. The major axes of clasts are oriented perpendicular to the foliations S_1 and define lineations L_1. The foliation S_2 which is parallel to the major fold axis D_2 is poorly defined by fracture cleavage. A small D_2 synform in the southwestern part of the region is outlined by the metasediments and by the enveloping Addington Complex. The nose of this structure hosts a tremolite-talc deposit. To the east of this synform the Addington Complex appears to loop into an antiform. This structure is suggested by rock attitudes and by airphotos, however, the author was not able to actually map the structure in the field and, therefore, it is not shown on the accompanying map (see back pocket). The structural patterns of the southwestern part of the map area suggest that the S-shaped structure and the synform in the Addington Complex have not been formed by the same structural event. All D_2 structures have generally northeastward striking fold axes and plunge gently to moderately to the northeast. Their axial plane foliations have shallow to moderate uniform dips to the southeast. The Northbrook Batholith and the Addington Complex are viewed by the author as composite dome structures.

EASTERN STRUCTURAL ZONE

The structural zone is underlain by marble with only minor isolated layers of mafic metasedimentary schist and metavolcanics and by a number of the intrusive bodies. The metasediments exhibit northeastward striking (N20E to N30E) stratiform foliations S_1 with predominant shallow to moderate (30 to 50 degrees) dips to the south. The changes in the rock attitudes may indicate that this unit was subsequently folded into antiformal and synformal D_2 structures. Due to the lack of mappable subunits these structures are difficult to trace in the field. At the contact with the Lavant Gabbro Complex, the foliations in the metasediments face southeastward, away from the body. In the southeastern part of the map area the metasediments and the metavolcanics were deformed around the Dalhousie Amphibolite Complex.

The Lavant Gabbro Complex is situated southeast of the Robertson Lake Shear Zone; the extreme southwestern part of the body lies in the shear zone. It extends from south of the southern boundary northeastward to and beyond the northern boundary of the map area for a length of approximately 48 km. Within the map area, the body parallels the northeastward striking regional trend, however, north of the map area discordances were recorded (Smith 1958). The Lavant Gabbro Complex rocks display primary textures, structures, and most of the primary mineralogy. The orientation of carbonate inclusions within the complex is generally concordant with the trend of the underlying supracrustal host rocks.

The relation of the Lavant Gabbro Complex to the tectonic events in the area is difficult to ascertain. Smith (1958) suggested that the complex might have been cushioned by mobile limestone and behaved as a large competent mass which was shattering rather than shearing. Two kilometres southwest of Gemmills Hill, the Addington Complex encloses about a 2 km long and up to 300 m wide concordant inclusion of gabbroic rocks which have been deformed and recrystallized to fine- to coarse-grained hornblende plagioclase gneiss. Similar to the Lavant Gabbro Complex, the inclusion is cut by discordant granodiorite and aplite dikes which have been little deformed and non-aligned. If the inclusion was originally part of the Lavant Gabbro Complex that has been separated from the main body, technically then the Lavant Gabbro Complex would at least predate the D_2 deformation.

The Dalhousie Amphibolite Complex is hosted by metasediments and metavolcanics. The original shape of the intrusion is difficult to ascertain since its central part has been intruded by the late stage Barbers Lake Intrusion. Further, the body is segmented by supracrustal rocks into 3 separate dome-shaped segments.

Unlike the Lavant Gabbro Complex most of the rocks of the Dalhousie Amphibolite Complex are well recrystallized and display a granoblastic to granoblastic-foliated fabric. The rocks in the southwestern segment display a strong planar-linear fabric, particularly west of Crains Lake where there is an irregular pattern of foliations. Contrasting textures and structures are encountered predominantly in the southwestern part of the body where the rocks, showing complete recrystallization and strong foliation, are found a few hundred metres from gabbro with strongly strained but well-preserved primary plagioclase laths. Pyroxenite, which is the predominant rock type in the northeastern segment, exhibits strong fracturing, but its texture and mineralogy are primary. The supracrustal rocks exhibit a pattern of deformation around the intrusion, particularly along the southeastern contacts of it.

As mentioned above, the compositional characteristics of the Dalhousie Amphibolite Complex suggest that it is a rather lower level intrusion unrelated to the Lavant Gabbro Complex. The shape of the body, degree of recrystallization, and inhomogeneous character of deformation and recrystallization suggest that the body is early tectonic to possibly pretectonic and that it has been subjected to polyphase deformation and metamorphism.

During the regional deformations, the body has undergone cataclasis and some evidence suggests that it could have been separated from its roots and possibly rotated. This tectonic history could account for the localized deformation of the supracrustal rocks, the segmentation of the body, as well as the shapes and

orientation of the individual rock segments. Such a previously deformed body would be very susceptible to subsequent thermal metamorphism which has been brought about by the late stage Barbers Lake Intrusion.

The Elphin Intrusion and the Barbers Lake Intrusion are the least deformed to undeformed felsic plutonic bodies within the region. The Elphin Intrusion is intrusive into the Lavant Gabbro Complex. Its contact with the Lavant Gabbro Complex is gradational through a zone of hybrid rock types. Although the rocks are massive, the Elphin Intrusion stretches northeastward, parallel to the regional strike-trend. Similar to the Lavant Gabbro Complex, the intrusion could have been protected from deformation by a carbonate rock cushion, and thus it may be older than its textural and structural characteristics suggest.

The Barbers Lake Intrusion is roughly circular, and discordant to the regional strike trend. Its rocks are undeformed and display igneous texture, structure, and mineralogy. The Barbers Lake Intrusion postdates the Elphin Intrusion and is considered to be the youngest plutonic body within the map area.

FAULTS

One of the most important structural elements in the map area is the Robertson Lake Shear Zone which passes northeastward through the villages of Robertsville and Mississippi Station. The shear zone is a structure of regional scale and extends farther northeastward and southwestward beyond the map boundaries for a total length of about 80 km (Wolff 1979, 1981). It forms a prominent topographic depression covered partly by Pleistocene deposits. Within the map area the shear zone is 300 to 700 m wide and its strike trend is N15E to N30E with shallow to moderate (30 to 60 degrees) dips to the south. The shear zone contains mylonitized metavolcanics, clastic and carbonate metasediments, and smaller amounts of Addington Complex and Lavant Gabbro Complex rocks. All these rocks are strongly chloritized, carbonatized, silicified, and fractured; fractures are commonly filled with a mixture of carbonate, chlorite, epidote, and pyrite. Slickensides suggest that the relative movement of the fault has been west side up, east side down, thus the fault can be classified as a normal dip-slip fault.

A fault contact between the Northbrook Batholith and the Addington Complex is implied in part from lineaments along the boundaries between these 2 lithologic units, and to a greater degree from the faulted-in blocks of the Northbrook Batholith within the Addington Complex and from the interfering fold patterns in the southwestern part of the map area. A number of approximately eastward (N80E) striking faults dominate the western and central-western parts of the region. Most of these faults are marked by swampy depressions and stream beds forming prominent lineaments and are readily apparent on air photographs. The fault zone along the upper Black Creek contains concordant calcite veins.

The eastward trending fault system postdates the above described northeastward striking faults; i.e. the northeastward trending faults are offset by the eastward trending faults.

Joints developed in the plutonic complexes strike N45W to N60W and N80W to N90W and have nearly vertical dips. The joints trending N45W to N60W are more prominent and are also imposed on the supracrustal rocks. They control a system of pegmatite dikes and quartz veins within the Addington Complex.

Stratigraphic Interpretation

Table 3 lists the main rock units of the area in a stratigraphic order. It is based on data published by L.T. Silver and S.B. Lumbers (1965) from rock units in the Bancroft-Madoc Area and on field observations and interpretations of the author. Because of the spread of radiometric ages and the somewhat unclear field relationships, in places, the stratigraphic order presented here is tentative. More high precision geochronological and detailed structural studies are needed to come to a better understanding of the geological history of the map area.

TABLE 3. INFERRED AGE RELATIONSHIP BETWEEN THE LITHOLOGIC UNITS IN THE DALHOUSIE LAKE AREA.

Listed isotopic data are those of correlative rock groups from the Bancroft-Madoc area (Silver and Lumbers 1965).

1050 ± 20 Ma	Intrusions of pegmatite dikes and sills Barbers Lake Intrusion Elphin Intrusion
Not later than 1050 ± 20 Ma	Deposition of Flinton Group[a]
	Unconformity
Not before 1125 ± 25 Ma	Lavant Gabbro Complex
1125 ± 25 Ma	Addington Complex[b]. Quartz monzonite and potassic granite plutons (Lumbers 1967).
1250 ± 25 Ma	Northbrook Batholith. Trondhjemite-sodic granite group (Lumbers 1967). Dalhousie Amphibolite Complex
1310 ± 15 Ma	Metavolcanics and metasediments Hermon and Mayo Groups (Lumbers 1967)

a) Moore and Thompson (1980) give 1080 - 1050 ± 25 Ma as an approximate time limit for the deposition of the Flinton Group.

b) Krogh and Hurley (1968) determined the isotopic age of the Addington Complex in the Kaladar area to be 1035 ± 42 Ma.

Correlation of Geology and Geophysics

Two types of aeromagnetic pattern (Geological Survey of Canada 1952) dominate the region: wide contour spacing and dense contour spacing. The wide contour spacing is typical over carbonate and clastic metasediments, metavolcanics, the Northbrook Batholith, and the Elphin and Barbers Lake Intrusions where the map shows gamma values of 900 to 1300. Areas with stronger magnetic gradients are characterized by values of 1000 to 1500 gammas. The Addington Complex contour spacing is dense. The Lavant Gabbro Complex displays inconsistent aeromagnetic patterns of both dense and wide contour spacing. North of Smith Bay where gabbro is the predominant rock type, aeromagnetic depressions occur. It is likely that the Elphin Intrusion which intrudes the Lavant Gabbro Complex in the area south of Smith Bay extends northeastward at depth since the aeromagnetic patterns of the Elphin Intrusion are similar to those north of Smith Bay. Other parts of the Lavant Gabbro Complex exhibit dense contour spacing which are practically indistinguishable from the Addington Complex pattern. The magnetite deposit within the Lavant Gabbro Complex east of the village of Robertsville does not have any expression on the aeromagnetic map and the pyroxenite mass north of Barbers Lake is hardly recognizable. The pyroxenite displays medium contour spacing which is gradational from the wider contour spacing of the neighbouring marble. Denser contour spacing across Fergusons Mud Lake indicates a possible extension of the pyroxenite mass under the carbonate cover. In general the northeastward striking structural trends in the map area are very well demonstrated by the aeromagnetic contours. A fault zone south of Cranberry Lake is expressed by magnetic depressions whereas other major fault zones do not have apparent aeromagnetic expression.

Economic Geology

Mineral exploration in the Dalhousie Lake area dates back to the 1880s and is closely related to the construction and opening of the Kingston to Pembroke railway route. The Robertsville (Mississippi) Mine is one of several deposits which were developed along this railway route. A calcite quarry was operated by Marlhill Mines Limited in the 1940s. Between 1946 and 1958, the mineral exploration was base metal oriented. Since the late 1950s the uranium occurrences in pegmatites have become the prime target of exploration activities in the area. Current mineral production consists of production of tremolite-talc and sand and gravel.

A list of assessment work reports and mineral occurrences is shown in Table 4. Unless otherwise stated, the information presented in this report was obtained from the Assessment Files Research Office, Ontario Geological Survey, Toronto. The exploration work listed in Table 4 under property name has not necessarily been conducted by the present or last owner.

METALLIC MINERALIZATION

COPPER

A few occurrences of copper observed within the map area are found in different geological settings. Chalcopyrite is the major copper mineral in all of the occurrences. At 2 locations malachite is also present.

Copper and Gold in Quartz Veins

South of the village of Robertsville (Picamine Copper Gold Mines Limited, property number 7) chalcopyrite occurs in a system of narrow (12 to 35 cm) stratabound subparallel quartz veins which are hosted by the Lavant Gabbro Complex. The quartz veins, although hosted by massive rocks, strike N30 to 50E, and dip 60 degrees south, parallel with the regional trend of the neighbouring foliated lithologies. The ore minerals in the quartz veins are chalcopyrite, pyrite, calcite, and secondary malachite. The chalcopyrite and pyrite are irregularly scattered in pods up to 5 mm in diameter and also form narrow stringers throughout the veins. The distribution of sulphide mineralization is irregular. Parts of the veins are barren; other parts contain up to 20 percent of combined chalcopyrite and pyrite. Gold was reported from this site by D.F. Hewitt (1964). A selected grab sample collected by the author from 1 of the waste dumps yielded 4 percent Cu, 7,600 ppb Au, and trace Ag (analysis by Geoscience Laboratories, Ontario Geological Survey, Toronto).

Disseminated Chalcopyrite in Carbonate Rocks

In a shallow test pit on the side of a large pegmatite sill 800 m south of Otter Lake, rusty weathered massive pyroxene-garnet-hematite-calcite rock is exposed that contains small grains (2 mm in diameter) of chalcopyrite and malachite sparsely scattered within pink, coarse-grained calcite. A grab sample collected by field party personnel and analyzed by the Geoscience Laboratories, Ontario Geological Survey, Toronto contained 0.3 percent Cu. The area of the pit is underlain by the Northbrook Batholith and a large pegmatite sill. The mineralization described is on a property owned by Consolidated Imperial Resources Limited (2).

IRON OXIDES

Magnetite occurs as an accessory mineral in many rock types. Significant concentrations of this iron oxide, however, also occur in the area and were extracted at the Robertsville (Mississippi) Mine and nearby Mary Mine. These 2 deposits are hosted by gabbro-diorite of the Lavant Gabbro Complex. Ore samples from the mine dump examined by the author consist of the host rock gangue and of fine- to coarse-grained magnetite in a patchy mixture of pyroxene-hornblende-calcite. Smaller amounts of pyrite and epidote are also present. The mine openings are flooded and therefore a detailed study of the ore in place is not possible. I.D. Ingall (1901) described the ore as forming extensive irregular patches and veinlets within the country rock. Magnetite also occurs as disseminations in the host gabbro-

diorite. It is of significance that this deposit lies 500 m from the contact of the Elphin granite intrusion and 500 m from the contact with the supracrustal rocks. The presence of carbonate and other supracrustal rock inclusions within the Lavant Gabbro Complex is not uncommon particularly in the marginal parts of the body. The irregular character of the deposit, the mineral assemblages, and geological setting suggest that the ore may be of contact metasomatic origin.

A small occurrence of magnetite-pyroxene rock of probable contact metasomatic origin is found in a narrow band of marble within the Addington Complex. This showing is exposed in a shallow test pit and is located about 230 m southwest of Marlhill calcite quarry. Small magnetite grains occur as an accessory in gabbro-diorite rocks of the Lavant Gabbro Complex, in the mafic members of the Dalhousie Amphibolite Complex, and in some pegmatites.

MOLYBDENUM

Minor amounts of molybdenite occur disseminated in a pegmatite in the southwestern part of the region.

SULPHIDE MINERALIZATION

Distributed throughout the map area are several occurrences of pyrite that in places are accompanied by small amounts of pyrrhotite and chalcopyrite.

Pyrite forms stratiform bands and irregular disseminations in metavolcanics and siliceous clastic, carbonate, and muddy metasediments. Minor pyrrhotite accompanies pyrite in the metavolcanics. Although distributed throughout the map area, this type of mineralization is most prominent in the siliceous clastic metasediments (unit 2c) exposed in the nose of the Cross Lake Antiform in the northwestern part of the map area.

Veinlets, stringers, seams, patches, and fine disseminations of pyrite are found in many parts of the major shear zone that goes in a northeastward direction through much of the area. The most extensive pyrite mineralization occurs in the sheared parts of the Lavant Gabbro Complex and in the metavolcanics southwest of the village of Robertsville. Pyrite, commonly accompanied by carbonate, chlorite, quartz, epidote, and minor chalcopyrite, fills fractures in the sheared rocks. Two grab samples from highly sheared and pyritized zones in the Lavant Gabbro Complex collected by the author at Boundary Hill and along Highway 509 about 1.4 km south of the Ram Petroleums Limited (8) plant, yielded 0.045 percent Cu and 0.50 percent Cu respectively (Geoscience Laboratories, Ontario Geological Survey, Toronto).

Pyrite is a common accessory mineral in the mafic and intermediate rocks of the Lavant Gabbro Complex and in the Elphin Intrusion.

Some of the small quartz veinlets intruding the Lavant Gabbro Complex carry minor disseminated or patchy pyrite. Such occurrences are marked "py" on the accompanying map (see back pocket).

URANIUM AND THORIUM

Uranium and thorium mineralization in the map area is concentrated in pegmatites. Although many pegmatite bodies (unit 13) occurring in almost every rock formation throughout the region exhibit above-background radioactivity, the most promising pegmatites are those hosted by the Northbrook Batholith, the Addington Complex, and the metasediments and metavolcanics in the southwestern and the west-central parts of the map area. Field party personnel recorded radiometric anomalies of 5 to 8 times background and locally 50 to 80 times background in the above area. Stratified metasediments and metavolcanics, foliated parts of the Addington Complex, and the foliated border zones of the Northbrook Batholith in general are intruded along the foliation planes by pegmatite sills whereas the more massive Northbrook Batholith and Addington Complex are intruded by pegmatite dikes and dike swarms. Large and continuous pegmatite sills appear to contain larger quantities of radioactive material than narrow discontinuous and crosscutting dikes.

TABLE 4. PROPERTIES AND OCCURRENCES IN THE DALHOUSIE LAKE AREA.

No. on Map	Property Name	Date	Type of Work	Min. seen in field	Min. Reported	Analyses by GLOGS	Assays Reported	Source
1	AJM Explorations Ltd.	1956-1980	ARS, GRS, DD, SW, GL	Rad, Mo	U, Th	U, Th	U, Th	AFRO
2	Consolidated Imperial Resources Ltd.	1975-1977	GRS, GL, DD	Rad, cp	U	Cu	U, Th	AFRO
3	Corval Corp. Ltd.	1952-1958	DD, GL, GS		Cp, py		Ag	AFRO
4	V. Emmery			Rad		U, Th		
5	Groundstar Resources Ltd.	1976-1980	ARS, GL, SW, DD	Rad	U		U, Th	AFRO
6	Marlhill Mines Ltd.	1940s	Abandoned quarry	Calcite	Calcite			Smith 1958
7	Picamine Copper Gold Mines Ltd.	1946-1948	SW	py, cp, mc	py, cp, po	Cu, Au		Smith 1958
8	Ram Petroleums Ltd.	1930s, 1946, 1972-1977	SW, DD, In production	trem, talc	trem, talc			AFRO; Smith 1958, Hewitt 1972

TABLE 4.CONTINUED.

No. on Map	Property Name	Date	Type of Work	Min. seen in field	Min. Reported	Analyses by GLOGS	Assays Reported	Source
9	Rain Petroleums Ltd. and Tamen Resources Ltd.	1975-1976	GRS	Rad	Rad			AFRO
10	Riddell, D.W.	1977	DD	Rad	Rad			AFRO
11	Robertsville (Mississippi) Mine, Mary Mine	1880s	Abandoned mine SW, DD	mag, py	mag, py			Ingall 1899, Smith 1958

Abbreviations

AFRO	Assessment Files Research Office, Ontario Geological Survey, Toronto
ARS	airborne radiometric survey
GRS	ground radiometric survey
DD	diamond drilling
GI	geological survey
GLOGS	Geoscience Laboratories, Ontario Geological Survey, Toronto
GS	geochemical soil sampling
Min	mineralization
Rad	radioactivity
SW	trenching, test pits

Metal and Minerals

Ag	silver
Au	gold
cp	chalcopyrite
Cu	copper
mag	magnetite
mc	malachite
Mo	molybdenum
py	pyrite
Th	thorium
trem	tremolite
U	uranium

In the field, pink pegmatites and white pegmatites can be distinguished. The pink pegmatites intrude predominantly massive lithologies (Northbrook Batholith, Addington Complex) and form both dikes and sills, whereas the white pegmatites intrude predominantly the metavolcanics and metasediments in the form of sills. Both pegmatite varieties are radioactive where they occur in the Northbrook Batholith and Addington Complex or where they are hosted by metavolcanics and metasediments that are enclosed by the Northbrook Batholith and Addington Complex. Radioactive minerals are unevenly distributed within an occurrence and are associated with the mafic minerals of the pegmatites, i.e. with biotite, magnetite, and hornblende. They appear to be concentrated in fractured and sheared pegmatites and in the contact zones of pegmatites. Radioactive pegmatites commonly exhibit a yellow staining and brick red alteration. Correlation of the radiometric map of the area (Ford and Charbonneau 1979) with the geological map shows, that highly radioactive zones coincide roughly with the zones of metavolcanics and metasediments.

It can be summarized, that a large population of uraniferous pegmatites is concentrated in the belt of metasediments and metavolcanics which is most deformed by folding and faulting.

NONMETALLIC MINERALIZATION

CALCITE

A vein of coarsely crystalline calcite occurs about 2.5 km west of the village of Robertsville and had been mined by Marlhill Mines Limited (6) in the late 1940s (Smith 1958). All of the accessible calcite has been mined. The continuation of the vein at depth and across a swamp is not known. The vein occupies a N80W striking fault zone. No other occurrence of this type has been seen in the map region.

MARBLE

The carbonate metasediments underlie large areas in the northeastern and the southeastern parts of the region and consist of a variety of different carbonate and calc-silicate as semblages. The majority of the exposures are composed of either calcite-rich marble (map unit 5a, c) or dolomite-rich marble (5b). In the southeastern part of the map area, pure calcite marble occurs that might be of economic potential.

QUARTZ AND FELDSPAR

Pegmatite dikes and sills are common particularly in the western part of the region. Most of the white and pink pegmatite phases are relatively fine grained. Large bodies of very coarse-grained to blocky pegmatites favoured for feldsapr production are not common in the area. No attempt has been made by exploration and mining companies to evaluate the pegmatites of the area.

TREMOLITE - TALC

Tremolite is a common rock-forming mineral in impure marble and dolomitic marble.

At 1 location in the map area a tremolite deposit is presently mined by Ram Petroleums Limited. It is located 4 km west of the village of Robertsville and forms a zone up to 83 m thick (Assessment Files Research Office, Ontario Geological Survey, Toronto) near the nose of a synform of metasediments. Small-scale folding is present in the tremolite zone. Both the metasediments and the tremolite horizon are enclosed by the folded Addington Complex.

The tremolite in the high-grade schistose ore is white to off-white asbestiform to transparent blade-like; lower grade ore consists of pale green tremolite-actinolite phlogopite schist.

SAND AND GRAVEL

Sand and gravel pits occur throughout the area and were used by the local construction industry. Large deposits of sand and gravel are found along the abandoned railway south of Robertsville. Cone-shaped sand and gravel deposits form prominent topographic features near and east of the Snow Road Station. Similar deposits are being extracted south of McDonalds Corners.

DESCRIPTION OF PROPERTIES

The history of exploration given in this report does not extend beyond December 1981 and is limited to company reports available to the public and to data obtained by field party personnel during mapping. The following or parts of properties are also described by the author in a geological report on the Ardoch area (Pauk 1982b): AJM Explorations Limited, Consolidated Imperial Resources Limited, Groundstar Resources Limited, and Ram Petroleums Limited.

COPPER AND GOLD

CORVAL CORPORATION LIMITED [1958] (3)

The Corval Corporation Limited property of 4 contiguous claims is located along the southern boundary of Palmerston Township about 2 km southeast of the village of Robertsville. In the north the claims are adjacent to the Picamine Copper Gold Mines Limited property. These claims were formerly part of the Picamine Copper Gold Mines Limited property.

In 1952, a 116 m deep diamond-drill hole was put down in the southeastern corner of the property by D.W. Riddell. According to the core description the main underlying rock types in the property are gabbro and grey granite. From 62 to 66 m depth, fine pyrite and chalcopyrite were reported. Analyses of 3 samples from the above core section revealed traces of gold and 0.25 to 0.70 oz silver per ton. A silicified and granitized fault breccia was intercepted at depths of 78.3 to 87.3 m, 98.3 to 99 m, and 112 to 113.6 m. (Assessment Files Research Office, Ontario Geological Survey, Toronto).

In 1957 Corval Corporation Limited carried out geological and geochemical surveys on 4 claims of the property. Two of these claims were held under option from Quebec Metallurgical Industries Limited. The company reported minor occurrences of pyrite. In 1958, a 27 m deep hole was diamond drilled by an unknown individual or company in the northwestern part of the property (Assessment Files Research Office, Ontario Geological Survey, Toronto). No further information was reported and the claims were allowed to lapse.

Picamine Copper Gold Mines Limited (7)

Smith (1958) reported that between 1946 and 1948 some prospecting was carried out on lots 1 and 2, concession VIII and IX in Palmerston Township by a company known as Picamine Copper Gold Mines Limited. He reported that some surface work (2 test pits and 2 trenches) and diamond drilling were carried out at that time.

The original discoveries were made in the 1870s when some shallow pits were sunk. In the 1920s, 2 large pits were put down. By 1949 there were a total of 10 pits when the deposit was optioned by Picamine Copper Gold Mines Limited from Picamine Prospecting Syndicate. A sample of 500 lbs. shipped to Mines Branch in Ottawa around 1939 gave an assay of 32 percent copper, 30 percent sulphur, and 29.50 percent iron from its concentrate (Source Mineral Deposit Records, Ontario Geological Survey, Toronto).

During the present survey 4 blast pits and 1 trench were located about 200 m south of the edge of the farm clearing in this area. The workings are situated on the farm of T. Riddell of Robertsville and are accessible by a private road from the farm. In the south, the property is adjacent to the Corval Corporation Limited claims.

The pits distributed about 20 to 25 m apart were blasted in a system of subparallel quartz veins striking N30E and dipping 60 degrees south, that is parallel to the regional strike of the neighbouring foliated lithologies. The thickness of the quartz veins ranges from 12 to 35 cm. The contact between the veins and the host rock is gradual and is made up of a sheared, fractured, and chloritized mixture of host rock and quartz. One of the veins was traced by trenching for about 20 m. The veins are mineralized with chalcopyrite, pyrite, malachite, and carbonate. Small quartz vugs also occur in the veins. Chalcopyrite occurs in clots up to 8 mm in diameter and in stringers in the veins. The distribution of the sulphide mineralization varies laterally and across the strike of the quartz veins. The best specimens contained up to approximately 20 percent of total sulphide minerals with chalcopyrite predominant. A grab sample collected by the field party personnel from the rock dump yielded 4 percent Cu, 7,600 ppb Au, and a trace Ag (Geoscience Laboratories, Ontario Geological Survey, Toronto). An isolated 2 m deep pit lies in a cedar bush about 200 m northwest of the above workings. A quartz vein about 30 cm thick striking N50E and dipping to the south is exposed in the northwest corner of the pit. The mineralization consists of pods of pyrite up to 2.5 cm in diameter and sparsely disseminated small grains of chalcopyrite. All the property is underlain by the Lavant Gabbro Complex represented here by fine-grained gabbro-diorite and hybrid rocks cut by granite-pegmatite and white aplite veins. All the quartz veins on the property lie in close proximity (about 500 m) of 2 fault zones; the N15E to N30E striking Robertson Lake Shear Zone and a N75W striking transverse fault.

IRON OXIDES

Robertsville (Mississippi) Mine [1951] (11)

A number of old mine openings are located on lots 3 and 4, concession IX, Palmerston Township, about 1.5 km east of the village of Robertsville. The access to the mine is gained by a gravel road extending east from Robertsville to the village of Elphin.

The iron mine was owned by the Mississippi Mining Company Limited and operated in the 1880s (Ingall 1901). In the late 1880s some work on the property was performed by Kingston and Pembroke Mining Company (De Kalb 1899, p.31).

The early development was the largest one and consisted of the main pit, a couple of open cuts, a shallow pit, and 2 shallow test pits. Additional openings called "The Mary Mine" included 3 open cuts and 1 adit. They are located about 160 m northwest of the main pit. The main open pit was of irregular shape, about 66 m deep and 36 m long and inclined on average about 52 degrees to the south.

The main magnetite zone exposed by workings strikes N42E and extends for a strike-length of 213 m. The width of the ore zone is about 15 m (Ingall 1901; Shklanka 1968, p.141). Figure 2 is a geological map showing the location of some of the workings at the Robertsville (Mississippi) and Mary Mines (Rose 1958, p.52).

The near surface ore has all been mined out. In the late 1880s a hole diamond drilled from the hanging-wall at an angle of 65 degrees encountered more mineralization at a depth of about 46 m below the bottom of the main pit (Ingall 1901).

In 1899 the mine was operated on lease from H.A. Ferguson of Kingston to F.W. Schwendiman and Thomas Barnes. Some diamond drilling, widening, deepening, and dewatering of the pit were performed and the ore production resumed (De Kalb 1899, p.31). Output of ore averaging about 40 tons a day was reported by C. De Kalb (1901, p.128).

In 1918 and 1919 the property was briefly worked by the Poe Mining Company (Source Mineral Deposits Files, Ontario Geological Survey, Toronto).

A 5 ton sample of crude ore from the Robertsville (Mississippi) Mine waste dump tested by the Mines Branch, Department of Mines, Ottawa in the mid-1920s averaged 28 percent Fe, 0.004 percent S, and 0.28 percent P. Testing indicated that a concentrate averaging 70.50 percent Fe, 0.014 percent P, and 0 percent S could be obtained with recovery grade of 91.80 percent (Timm 1925a, p.124, 125).

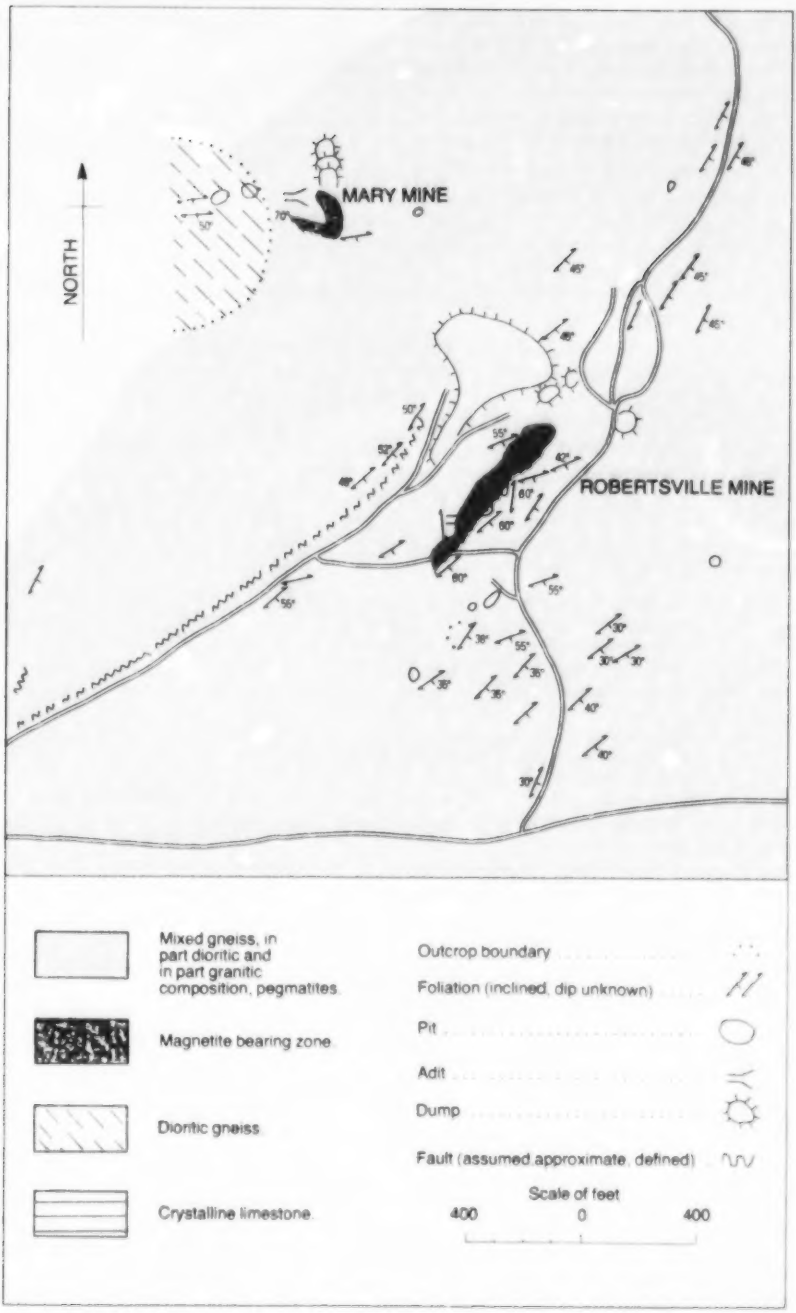

Figure 2. *Robertsville magnetite deposit, Palmerston Township, Frontenac County, Ontario, (from Rose 1958, p.52, Figure 18, with minor changes).*

A chemical analyses of magnetite from the Robertsville (Mississippi) Mine showed 56.68 percent iron and 0.046 percent phosphorus. Spectrographic analyses of an ore sample from the mine showed a minor content of titanium and traces of vanadium (Rose 1958, p.51).

In 1951 a dip needle survey was conducted by Minnesota-Huron Mining Company (Smith 1958; Shklanka 1968, p.141) and 2 diamond-drill holes were drilled by Trent River Iron Limited (Rose 1958, p.51; Shklanka 1968, p.141).

The ore in the mine was described by Ingall (1901) as a veiny, commonly vuggy mass of irregularly reticulated magnetite with pink and cream coloured calcite and hornblende. The magnetite also occurred in irregular patches, in veins, and as scattered grains throughout the country rock. The ore in the main pit contained about 50 percent magnetite and 50 percent gangue minerals and country rock (Ingall 1901).

The ore mixture examined by the author in the waste dump contained coarse-grained and some fine-grained magnetite intermixed with patches and bands of fine to coarse crystalline pyroxene, hornblende, and calcite. Smaller amounts of epidote and pyrite are also present.

About 30,000 to 40,000 tons of ore were extracted by Mississippi Mines Limited and shipped to the United States in the 1880s. The ore was said to be rich, containing no impurities (Government of Ontario 1890). Available records indicate that between 1890 and 1919 about 20,000 tons were extracted and shipped from the mine (Source Mineral Deposits Records, Ontario Geological Survey, Toronto; Shklanka 1968, p.141).

Several flooded pits and a large waste dump is all that remains from a once extensive operation. The Lavant Gabbro Complex represented by fine- and medium-grained gabbro-diorite of a patchy character underlies the area of the old mine. Gabbro-diorite rocks in many places are intruded by a network of pink granite-pegmatite veinlets and by larger offshoots of the Elphin Intrusion that is exposed nearby.

Smith (1958) writes that the Robertsville magnetite deposit is associated with narrow bands of limestone in diorite.The deposit is of a contact metasomatic origin. This is suggested by Smith's observations and by the irregular character of the orebody, its mineral assemblages, and its geological setting near the contact of the Elphin Intrusion.

URANIUM AND THORIUM

AJM Explorations Limited (1)

The property owned by AJM Explorations Limited and covering about 21 km^2 is situated in the southwestern corner of the region and extends from the Black Creek area to the southwest, beyond the western and southern limits of the map area. Sixty-three claims are located in Palmerston Township and 12 claims are located in Olden Township. The access to the Palmerston Township group of claims is gained by a gravel road extending west from the village of Robertsville. Claims located in Olden Township and the southern part of the property are accessible via the paved Ardoch Road. Sixteen claims within the map area are underlain by a variety of lithologies comprising the carbonate and clastic metasediments, metavolcanics, the Addington Complex, the Northbrook Batholith, and a band of the Flinton Group metaconglomerate just along the southwestern boundary. Large parts of the property beyond the western limits of the map area are underlain by the Northbrook Batholith, by metavolcanics, and by metaconglomerate. The rocks have been deformed into a northeastward trending synformal and antiformal structure (Pauk 1982b). The band of metaconglomerate along the western boundary forms the southern limb of the antiform. All lithologies including the metaconglomerate (Flinton Group) are intruded by many white and pink pegmatite sills and dikes. Two approximately eastward (N80E) trending faults cut across the northern part of the property.

The first reported work on the property had been undertaken by J.& H. Eastman and D.W. Riddell and Harvey in 1956 and 1957. Eighteen holes for a total length of 584 m were diamond drilled in the Black Creek area along the eastern part of the property to examine the extent of uranium mineralization at depth. Various parts of the present AJM Explorations Limited property have been staked and investigated since then. A summary of exploration programs carried out on the property between 1957 and 1977 is listed in Table 5.

Radiometric surveys which were conducted on the property delineated a large number of radiometric anomalies ranging from 2 to 8 times background with some local high concentrations (13 times background). Many radiometric anomalies trend parallel to the strike of the rock formations; most promising areas were further investigated by diamond drilling. Assays were reported from the Olden Township claims and are listed in Table 4.

In 1979 AJM Explorations Limited carried out an airborne radiometric and magnetic survey over a large part of the property. The survey delineated a number of promising targets and the company started a diamond drilling program in 1980. Twenty-two diamond-drill holes were sunk in the east, the most promising part of the property (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Two pegmatite samples were collected for chemical analysis by the writer in the eastern part of the property where field scintillometer readings of about 15 times background were taken. The assays by the Geoscience Laboratories, Ontario Geological Survey, Toronto yielded 2.60 lb/ton U and 0.70 lb/ton Th and 3.00 lb/ton U and 0.980 lb/ton Th respectively.

This report compiles information gathered by the author during the mapping of the Ardoch area in 1980 and the Dalhousie Lake area in 1981. Complete data on AJM Explorations Limited property and on the extent of the exploration activity of the company were not available to the author at the time of completion of the Ardoch Area report (Pauk 1982b). The writer did not visit that part of the property that is located in Olden Township. In this area metaconglomerate was reported as the host rock of uraniferous pegmatites (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Consolidated Imperial Resources Limited (2)

The property of Consolidated Imperial Resources Limited consists of 14 contiguous claims and is located southwest of Otter Lake. Between 1975 and 1977 extensive exploration on uranium-bearing pegmatite dikes and sills was carried out by the company. In 1975 exploration was initiated with a scintillometer survey and sampling on 1 of the claims. The following year the company extended the ground radiometric survey to all 14 claims and later reported that the survey had been successful in the delineation of several zones of high radioactivity (Assessment Files Research Office, Ontario Geological Survey, Toronto). The uranium mineralization is hosted by pegmatites in the Northbrook Batholith, Addington Complex, and in narrow bands of metavolcanics and clastic and carbonate metasediments. Pegmatite dikes 0.60 to 1.20 m wide and few conformable pegmatites 30 to 60 m wide and continuous along strike for up to 360 m were located on the property. The assay results indicate the presence of low grade uranium mineralization accompanied by thorium. The ratio of uranium to thorium was found to be generally in order of 3 parts of uranium to 2 parts of thorium. The analyzed grab samples yielded from 0.10 to 1.30 lb/ton U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto). The best assays of the spot samples weighing 15 to 20 pounds were 0.70 lb/ton U_3O_8 and 0.50 lb/ton U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto). In 1977 Noranda Explorations Limited under the option from Consolidated Imperial Resources Limited carried out a radiometric survey and diamond drilling program on the property. Arcuate-shaped anomalies averaging 3.5 to 4.7 times background were located in the western part of the claim group. In the central part of the property the pegmatite dikes carried radiometric anomalies of 7.5 times background. The radioactive anomalies in this part of the claim group exhibited northeastward trending linear shapes. In the

TABLE 5. SUMMARY OF EXPLORATION PROGRAMS CARRIED OUT ON THE PRESENT AJM EXPLORATIONS LTD. PROPERTY FROM 1957 TO 1977.

Southwest part Olden Tp.	West part Palmerston Tp.	Central part Palmerston Tp.	East part Palmerston Tp.	East part Palmerston Tp.
Iso Uranium Mines Ltd., 1957 diamond drilling	Keevil Mining Corp. Ltd. (Under option from Substantial Developments Ltd.) 1969, airborne radiometric survey	Bijou Mines Ltd. 1977, ground radiometric survey and 1 diamond-drillhole (74 m)	Rexdale Mines Ltd., 1968 and 1969 ground radiometric survey, 32 diamond-drillholes (1215 m)	Geophysical Engineering Palmerston, 1976 airborne radiometric and magnetometer surveys, 11 diamond-drillholes (393 m)
Guardian Mines Ltd., 1968 ground radiometric survey, diamond drilling	Substantial Developments Ltd., 1970, ground radiometric and geological surveys			
Mid-East Developments Ltd. (under option from Guardian Mines Ltd.) 1976 and 1977 ground radiometric survey, diamond drilling	D.W. Riddell, 1976 ground radiometric survey			

The above information was taken from the Assessment Files Research Office, Ontario Geological Survey, Toronto.

eastern part of the property radiometric anomalies of irregular shape averaging 5 to 6 times background and locally up to 13 times background were delineated.

Analyzed pegmatite samples yielded from 0.10 lb/ton U_3O_8 to 1.70 lb/ton U_3O_8 with an average of 0.53 lb/ton U_3O_8 for 16 analyzed samples. A sample from a highly anomalous radioactive zone in the central part of the property revealed 7.80 lb per/ton U_3O_8 and 1.70 lb per/ton ThO_3 (Assessment Files Research Office, Ontario Geological Survey, Toronto). Five diamond-drill holes for a total length of 658 m were sunk in the central part of the property just along the western boundary of the area. Assayed core samples revealed 0.007 to 0.036 percent U_3O_8 and 0.03 to 0.05 percent ThO_2. A report on the diamond drilling indicated that no significant uranium mineralization was discovered at depth (Assessment Files Research Office, Ontario Geological Survey, Toronto).

V. Emmery Occurrence (4)

Some small highly radioactive zones were encountered by field party personnel just south of the southwest tip of Gibsons Lake where uranium mineralization occurs in pegmatite sills within metasedimentary schists and gneisses that are enclosed by the Addington Complex. The pegmatites are pale pink to white and contain abundant biotite. Uranium mineralization is indicated by the yellow coating of the secondary uranium minerals. Two grab samples collected by the writer from a single outcrop on this property yielded 14.20 lb ton/U and 1.20 lb ton/T and trace of U_3O_8 and ThO_2 respectively (Geoscience Laboratories, Ontario Geological Survey, Toronto). No assessment records are available from this patented property owned by V. Emmery and only a small trench and few blasted outcrops were found in the property.

Groundstar Resources Limited (5)

This large parcel constituted originally 65 claims: 37 claims were located within the map area; 28 claims were located west of the area boundaries.

In 1976 the Grange Mining Corporation Limited conducted an airborne radiometric and magnetometer survey on a group of 73 claims bounded by Crotch Lake in the west (outside of the map area), Gibsons Lake in the southeast, and Millers Lake in the northeast. This survey did not cover a group of 14 claims southwest of Otter Lake which are presently held by Consolidated Imperial Resources Limited. The report on the radiometric survey indicated that some radiometric anomalies warranted ground investigation. Between 1977 and 1980 Groundstar Resources Limited carried out a comprehensive exploration program of detailed geological mapping at a scale of 1:2400 (1 inch to 200 feet), trenching, and diamond drilling. The property is underlain by the Northbrook Batholith in the west (outside the western boundaries of the area), by metavolcanics and metasediments in the centre, and by the Addington Complex containing many layers of supracrustal rocks in the east.

Pegmatite sills are widespread particularly in the foliated lithologies (metavolcanics and metasediments) in the central and eastern part of the claim group. In some of these areas pegmatite sills are estimated to make up about 50 percent of the outcrop. The size of the pegmatites averages 7.5 to 15 m in width and over 60 m in length. A few very large pegmatites (60 X 183 m) were locally encountered. Assayed pegmatite samples revealed traces to 1.92 lb/ton U_3O_8 and two analyzed bulk samples yielded 0.040 lb per/ton U_3O_8 and 0.50 lb per/ton U_3O_8 (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Twenty-four holes totalling 1,765 m were diamond drilled by Groundstar Resources Limited in the most promising central and eastern parts of the property. The best assays obtained from the drill cores revealed 0.90-1.10 lb/ton U_3O_8; others averaged from 0.040 to 0.60 lb/ton U_3O_8. The report on the diamond drilling indicates that no significant uranium-rich zones were intercepted (Assessment Files Research Office, Ontario Geological Survey, Toronto). The western part of the property, which lies beyond the western limits of the map area is underlain by the

Northbrook Batholith where radioactive pegmatite dikes, sills, and swarms are less common. Consequently, 25 claims in this area were allowed to lapse in 1980.

Ram Petroleums Limited and Taman Resources Limited (9)

Six contiguous claims of the Ram Petroleum Limited and Taman Resources Limited property are located west and southwest of Millers Lake and are accessible by a bush trail from the boat landing at the western tip of Millers Lake. Ram Petroleums Limited and Taman Resources Limited acquired the property in 1976 and each have a 50 percent interest in the claims.

The property is underlain by the Addington Complex interlayered with metasedimentary and metavolcanic rocks. Radioactive showings are confined to coarse-grained pink pegmatite sills and dikes that contain abundant biotite, hornblende and magnetite. The companies carried out a scintillometer survey in 1976. Three large radioactive anomalies and a series of smaller anomalies were outlined and further investigation of the ground by trenching and diamond drilling was recommended (Assessment Files Research Office, Geological Survey, Toronto). Previous work recorded on the property consists of a ground radiometric survey conducted by W.C. Bidgood, E. Reid and D.W. Riddell in 1975 (Assessment Files Research Office, Ontario Geological Survey, Toronto). Two trenches about 3 m deep and 10 m long oriented across the strike of 2 large northeastward striking pegmatite sills were found by the field party on the property.

D.W. Riddell (10)

Uranium mineralization in pegmatites occurs approximately 1.7 km northwest and 1.6 km northeast of the village of Snow Road. In 1977 3 diamond-drill holes totalling 253 m were sunk on the property by D.W. Riddell, the then holder of 2 claims (Assessment Files Research Office, Ontario Geological Survey, Toronto). No appreciable uranium mineralization was encountered in the drillholes and subsequently the claims were allowed to lapse.

CALCITE

Marlhill Mines Limited (6)

A vein of white to creamy coarse crystalline calcite was quarried by Marlhill Mines Limited in the late 1940s (Smith 1958). The quarry is located 2.5 km west of the village of Robertsville and is accessible by a gravel road extending west from the village. The vein opening is about 25 m wide, about 110 m long, and 8 to 12 m deep. The vein strikes N80W and dips steeply (80 degrees) to the south. It crosscuts the host rocks the Addington Complex, with the layer of metasedimentary gneisses which are striking N40E. The material from the vein was removed to the level of an adjacent swamp. The calcite vein lies in a fault zone and appears to fill a depression created by the faulting. The extent of the vein at depth has not been investigated. The calcite was used in the pulp industry (Smith 1958).

TREMOLITE-TALC

Ram Petroleums Limited (8)

A tremolite-talc deposit in Palmerston Township has been in production since 1978. The deposit is located near the southwest boundary of the map area and is accessible by a mine road extending west from the Ram Petroleums Limited plant. The ore is extracted from an open pit and trucked to the Ram Petroleums Limited plant which is located at Highway 509 just south of the village of Robertsville.

The first recorded work on the property was undertaken by J.A. Cummings in the late 1930s. Several shallow pits were blasted in a talc-tremolite schist.

Material from the pits was analyzed in 1942 by the Industrial Minerals Division of the Bureau of Mines, Ottawa. The results of these analyses are shown in Table 6. Microscopic examination of the material from the pit indicated that the material

TABLE 6. ANALYSIS OF A FINE FLAKEY FIBROUS MINERAL FROM PALMERSTON TOWNSHIP.

Silica	58.38
Alumina	1.83
Ferrous oxide	0.55
Ferric oxide	0.76
Manganese oxide	0.04
Lime	7.82
Magnesia	25.90
Potash	1.14
Soda	0.71
Water above 105°C	3.06
Fluorine	0.30
Total	100.49

is a very friable flake-fibrous form of tremolite partly altered to talc (Assessment Files Research Office, Ontario Geological Survey, Toronto).

Hewitt (1972) reports that in 1946 some test pits were sunk by Montgomery and Scott of Havelock on the property. A mining lease for 10 years was granted to J.D. Cummings of Havelock in 1965. Ram Petroleums Limited acquired the property in 1970 and staked 5 additional claims. In 1971, 4 holes totalling 291 m were diamond drilled on the property. Split core samples and bulk samples were used for product evaluation tests. Sixteen different means of beneficiation were tested.

A geological survey was carried out by the company in 1972. The company records (Assessment Files Research Office, Ontario Geological Survey, Toronto) give descriptions of the deposit and the estimated ore reserves as in Table 7.

Tremolite Zones

Main Zone

This deposit extends partly around the nose and along the south limb of the syncline for a distance of at least 1600 feet. It attains an average width of more than 165 feet, probably because it is bordered here by actinolite-rich skarn and also because its location near the nose of the syncline may have been favourable for permeation of hydrothermal solutions and/or thickening by plastic flow. Sparse outcrops toward the south side of the zone show a generally higher actinolite content. Along strike to the east the zone is much narrower and, in addition, is displaced by faults. Grade is still good, however.

Southwest Zone

Average grade of this deposit located about 400 feet southwest of the main zone appears to be lower than that of the Main Zone and tonnage in sight is small. There is, however, a potential for improvement along strike, especially to the east. If there is any appreciable amount of actinolite skarn associated with this zone it must be under the pond to the south.

Far South Zone

An old pit, located about 800 feet south of the main zone, is sunk on fibrous light green actinolite and a finely crystalline, light green mineral that may be tremolite rather than actinolite. It is a restricted occurrence and of no economic importance.

The above-mentioned report on the geological survey carried out by the company in 1972 indicated the possible extension of the deposit and further exploration was recommended. Three holes for a total of 186 m were diamond drilled on the property in 1973 and 1976.

TABLE 7. ESTIMATED ORE RESERVES*

Zone	Length	Average Width	Average Mining Depth	Short Tons	Ore to Waste Ratio
Main Zone					
Central Block	800′	165′	200′	2,200,000	1 to 1.20
Combined West and East Extensions	800′	40′	50′	130,000	
Total Main Zone				2,330,000	
Southwest Zone	360′	50′	50′	75,000	
Total all Zones				2,405,000	

*Estimated average tremolite content of 65% or better.
Tonnage conversion factor of 12 cubic feet per ton.

**Assumed average pit wall slope of 45°. For open cuts to 50 foot depth, the ore to waste ratio should be more favourable.

Based on encouraging results obtained by previous surveys a program of bulk sampling was initiated in 1977. Approximately 45 tons of unweathered material from tremolite-talc zones was collected for mill testing and evaluation of the ore as an asphalt additive. An asphalt mix was designed by Thompson Research Associates Limited of Toronto to road test the physical characteristics of tremolite as an asphalt additive.

A total of 10 tons of tremolite was supplied to both Repac Limited and Warren Bithulic Limited who, acting as contractors to the Borough of North York, produced the recommended tremolite/asphalt mix (Assessment Files Research Office, Ontario Geological Survey, Toronto).

The property is underlain by clastic metasediments comprised of biotite-plagioclase-quartz gneiss to schist, hornblende-biotite-plagioclase gneiss, quartzite, and a few narrow layers of impure marble associated with the talc-tremolite horizon.

The tremolite-talc rocks represent a premetamorphic dolomitic limestone — dolostone horizon. All the metasedimentary sequence is enclosed by the granitic gneisses of the Addington Complex and the whole sequence has been folded into an east-northeastward plunging synformal structure.

The detailed geological mapping of the property at a scale 1:2400 (1 inch to 200 feet) documented that the main tremolite-talc zone occurs around part of the nose and along the south side of the synformal trough (Assessment Files Research Office, Ontario Geological Survey, Toronto). In the west and southwest the structure is distorted by faulting.

The ore zone is described as containing 3 major rock types (Assessment Files Research Office, Ontario Geological Survey, Toronto).

1. Actinolite Skarn and Schist: The actinolite skarn may contain some diopside and is medium green in colour, generally coarse grained, especially at the contact with pegmatite. Actinolite schist is a fine-grained schist of darker matrix containing larger, lighter bladed metacrysts probably of tremolite. The mineral chemistry and coarse-grained texture are attributed to the contact metamorphic effect of the large bodies of pegmatite.
2. Tremolite-Talc Schist: The tremolite-talc high-grade schist contains long-bladed, semi-aligned colourless to off-white to pale green tremolite. The size of tremolite crystals varies from 2 to 5 mm. One to ten percent of bronze coloured phlogopite commonly concentrated in the planes of schistosity are present. Some parts of the high-grade ore zone are described as more massive,

consisting of stubbly and intermashed tremolite crystals with only traces of phlogopite. The quality of the tremolite schist decreases with the progressive darkening of the schist due to the increasing amounts of actinolite in the rock.

3. Talc Schist: The talc schist is confined to several bands from 6 inches to several feet wide within the core of the main tremolite zone. It was suggested by the company geologist that the deposit probably originated from the combined alteration of dolomitic rocks by regional metamorphism and hydrothermal solutions (Assessment Files Research Office, Ontario Geological Survey, Toronto).

SUGGESTIONS FOR FUTURE MINERAL EXPLORATION

The occurrences of copper in the quartz veins hosted by the Lavant Gabbro Complex in the past have been examined by shallow surface workings only. Prospecting to depth may well be worthwhile.

Some parts of the major shear zone that cuts across the area show prominent sulphide mineralization - mainly pyrite, accompanied by small amounts of chalcopyrite. The presence of gold and copper in this shear zone was reported by Smith (1958) northeast of the map area. A thorough geochemical and geological examination of the shear zone in the present area is therefore recommended.

Gold and base metal occurrences have been found in the contact zone with the younger Flinton Group metasediments southwest of the mapped region (e.g. Addington Mines Limited, Ore Chimney Mine). Similar geological conditions exist in the southwestern part of the map area, where the younger Flinton Group conglomerate overlies the metavolcanics and other older lithologies. Although the geological conditions differ with respect to the grade of metamorphism, which is much higher in the present region, the potential of this unconformity deserves attention.

Uranium mineralization is associated with pink and white pegmatite sills and dikes occurring in the border zones of the Northbrook Batholith, in the metavolcanics and metasediments, and in the Addington Complex in the southwestern and west-central parts of the region.

The available data on the exploration of uranium prospects in the present area indicate that the uranium mineralization tends to be concentrated in spots. Although any pegmatite in this region may show considerable radiometric anomalies, the best exploration targets for low-grade high-tonnage uranium mineralization appear to be pegmatite sills because of their large dimensions and regular shape. The zones of weaknesses within the above-described lithologic units, such as shear zones and fault zones should also be considered as prime targets.

Old reports on the production and exploration of the iron mine at Robertsville indicate good quality iron ore extending downward below the former open pit operation to depth (Ingall 1901; Government of Ontario 1890).

Favourable original bulk composition, regional metamorphism, and structural deformation played important roles in the formation of the Ram Petroleums Limited tremolite deposit. Other tremolite-talc occurrences are possibly present in similar geological settings in the present or surrounding areas.

Other industrial minerals besides tremolite are possibly present in economic quantities within the area. Exploration for pure calcitic marble for the use in the paper industry and for use as decorative stone might be rewarding.

References

Ambrose, J.W., and Burns, C.A.
1956: Structures in the Clare River Syncline: A Demonstration of Granitization; p.42-53 *in* The Grenville Problem; edited by J.E. Thomson, The Royal Society of Canada, Special Publications No. 1, 119p.

Chapman-Kamilli, D.
1974: Progressive Metamorphism of the Cross Lake Granodiorite, Ontario, Canada; Geological Society of America Bulletin, Volume 85, p.1755-1762.

De Kalb, Courtenay
1899: The Condition of Ontario Mines; Ontario Bureau of Mines, Annual Report, Volume 8, Part 1, p.29-48.
1901: Mines of Eastern Ontario; Ontario Bureau of Mines, Annual Report, Volume 10, p.113-136.

Ells, R.W.
1904: Report on the Geology of Portions of the Counties of Renfrew, Addington, Frontenac, Lanark and Carleton; Geological Survey Canada, Annual Report for 1901, Volume 14, Part J, 79p. (To accompany Map Sheet No. 119, GSC Map 789, scale 1 inch to 4 miles).

Ford, K.L., and Charbonneau, B.W.
1979: Investigation and Regional Significance of Airborne Gamma Ray Spectrometry Patterns in the Sharbot Lake Area, Eastern Ontario; p.207-222 *in* Current Research, Part B, Geological Survey of Canada, Paper 79-1B, 420p.

Geological Survey of Canada
1952: Sharbot Lake, Frontenac and Lanark Counties, Ontario; Geological Survey of Canada, Aeromagnetic Series Map 69G, scale 1 inch to 1 mile or 1:63 360. Survey flown April, May, and October 1948.

Government of Ontario
1890: Ontario. Report of the Royal Commission on the Mineral Resources of Ontario and Measures for their Development; Printed by order of The Legislative Assembly, Toronto, Warwick and Sons, 556p.

Harding, W.D.
1951: Geology of the Olden-Bedford Area; Ontario Department of Mines, Annual Report for 1947, Volume 56, Part 6, 100p. Accompanied by Map 1947-5, scale 1 inch to 1 mile.

Henderson, E.P.
1973: Surficial Geology of Kingston (North Half) Map-Area; Geological Survey of Canada, Paper 72-48, 6p. Accompanied by Maps 7-1972 and 8-1972, scale 1:125 000.

Hewitt, D.F.
1956: The Grenville Region of Ontario; p.22-41 *in* The Grenville Problem, edited by J.E. Thomson, The Royal Society of Canada, Special Publications No. 1, 119p.
1964: Geological Notes for Map Nos. 2053 and 2054 Madoc-Gananoque Area; Ontario Department of Mines, Geological Circular No. 12, 33p.
1972: Talc in Ontario; Ontario Department of Mines and Northern Affairs, Industrial Mineral Report 40, 52p.

Ingall, I.D.
1901: Report on the Iron Ore Deposits along the Kingston and Pembroke Railway in Eastern Ontario; Geological Survey of Canada, Annual Report for 1899, Volume 12, Part 1, 80p.

Krogh, T.E., and Hurley, P.M.
1968: Strontium Isotope Variation and Whole Rock Isochron Studies, Grenville Province of Ontario; Journal of Geophysical Research, 73, p.7107-7125.

Lumbers, S.B.
1973: Geology and Mineral Deposits of the Bancroft-Madoc Area; p.13-29 *in* Geology of Parts of Eastern Ontario and Western Quebec, The Geological Association of Canada, Guidebook, edited by S.E. Jenness.

Moore, J.M. Jr., and Thompson, P.H.
1972: The Flinton Group, Grenville Province, Eastern Ontario, Canada; p.221-229 *in* Proceedings, 24th International Geological Congress, Montreal, Section 1, Precambrian Geology, 379p.
1980: The Flinton Group: A Late Precambrian Metasedimentary Succession in the Grenville Province of Eastern Ontario; Canadian Journal of Earth Sciences, Volume 17, No. 12, p.1685-1707.

Moore, J.M. Jr., and Morton, R.L.
1980: Geology of the Clarendon Lake Area, Counties of Frontenac and Lennox and Addington; Ontario Geological Survey, Open File Report 5316, 83p. Accompanied by map.

Pauk, L.
1982a: Precambrian Geology of the Ardoch Area, Frontenac County, Southeastern Ontario; Ontario Geological Survey, Preliminary Map P.2487, Geological Series, Scale 1:15 840 or 1 inch to 1 mile. Geology 1980.
1982b: Geology of the Ardoch Area, Frontenac County; Ontario Geological Survey, Open File Report 5381, 125p. Accompanied by Map P.2487.

Rivers, T.
1976: Structures and Textures of Metamorphic Rocks, Ompah Area, Grenville Province, Ontario; unpublished Ph.D. thesis, Department of Geology, University of Ottawa, Ontario.

Rose, E.R.
1958: Iron Deposits of Eastern Ontario and Adjoining Quebec; Geological Survey of Canada Bulletin 45, 120p.

Sethuraman, K., and Moore, J.M., Jr.
1973: Petrology of Metavolcanic Rocks in the Bishop Corners-Donaldson Area, Grenville Province, Ontario, Canada; Canadian Journal of Earth Sciences, Volume 10, Number 5, p.589-614.

Shklanka, Roman
1968: Iron Deposits of Ontario; Ontario Department of Mines, Mineral Resources Circular No. 11, 489p.

Silver, L.T., and Lumbers, S.B.
1965: Geochronological Studies in the Bancroft-Madoc Area of the Grenville Province, Ontario, Canada; Geological Society of America, Special Publication 87, p.156.

Smith, B.L.
1958: Geology of the Clarendon-Dalhousie Area; Ontario Department of Mines, Annual Report for 1956, Volume 65, Part 7, p.1-46. Accompanied by Map 1956-4, scale 1 inch to 1 mile.

Streckeisen, A.L.
1967: Neues Jahrbuch für Mineralogie; Abhandlinger 107, 2-3, p.144-240.

Timm, W.B.
1925a: Investigations in Ore Dressing and Metallurgy, 1923; Mines Branch, Canada Department of Mines, Ottawa, Publication No. 617, p.1-7, p.123-138.
1925b: Investigations in Ore Dressing and Metallurgy, 1924; Mines Branch, Canada Department of Mines, Ottawa, Publcation No. 643, p.3-91.

Winkler, H.G.F.
1965: Petrogenesis of Metamorphic Rocks; Springer-Verlag, New York, 220p.
1967: Petrogenesis of Metamorphic Rocks; Revised Second Edition, Springer-Verlag, New York, 437p.

Wolff, J.M.
1979: Geology of the Long Lake Area, Southern Ontario; Ontario Geological Survey, Open File Report 5271, 174p.
1981: Geology of the Sharbot Lake Area, Frontenac and Lanark Counties, Southeastern Ontario; Ontario Geological Survey, Open File Report 5336, 117p.

Wynne-Edwards, H.R.
1967: The Frontenac Axis; *in* Guidebook: Geology of Parts of Eastern Ontario and Western Quebec, The Geological and Mineralogical Association of Canada.
1972: The Grenville Province; p.263-334 *in* Variations in Tectonic Styles in Canada, edited by R.A. Price and R.J.W. Douglas, Geological Association of Canada, Special Paper No. 11, 688p.

Index

Actinolite skarn 49,50
Addington Complex .... 6,10,13-16,22,26, ... 28,30-35,37,40,44,45,47,48,50,51
Adit 42
Aeromagnetic pattern 35
Age relationships:
  Table 34
AJM Explorations Ltd. 5,41
  Property table 46
Almandine-amphibolite facies 9-11,28
Alteration 11,13,20,22,29
  Metasomatism 13,16,17,37
Amphibolite 18-20,29
Analyses 36,37,41
  Pegmatite 45,47
  Spectrographic 42
  Table 49
    see also: Assays
Anatexis 28
Anomalies 37,45,48
Antiforms 23,30,31,44
    see also: Cross Lake Antiform
Assays 41,45,47
  Pegmatite 47
    see also: Analyses

Barbers Lake 18,20,27,29
Barbers Lake Intrusion ..... 9,18,22, ... 24,32,33,35
Barnes, Thomas 42
Bidgood, W.C. 48
Bishop Corners, community 4
Black Creek 44
Boundary Hill 37

Calcite 36
  Quarry 36
Calcitic marble 51
Central Metasedimentary Belt 30
Chalcopyrite 14,36,37,41,42
    see also: Sulphide minerals
Chemical analyses:
  Iron 42
  Pegmatite 45
  Table 49
    see also: Analyses; Assays
Chert 14
Clastic metasediments, thin section 12

Consolidated Imperial Resources Ltd. 36,41,47
Contacts:
  Elphin Intrusion 37,44
  Metamorphic 28,29,50
  Supracrustal rocks 37
  Zones 13,16,40,51
Copper 51
Corval Corporation Ltd. 41
Crains Lake 11,19,20,32
Cranberry Creek 16,35
Cross Lake Antiform 11,12,30,31,37
Crotch Lake 47
Cummings, J.A. 48

Dalhousie Amphibolite Complex 9,11,15,19,25,29,32,37
Deformation .. 9,11,13,18,21,23,29-32,40
  Post-Flinton 30
Diabase dike 20
Diamond drilling 41,42,44,45,47-49
Dikes 20-22,37,40
  Diabase 20
  Pegmatite ..... 9,24,25,33,37, ... 40,44,45,48,51
Diorite, thin section 21, 22
Dip needle survey 44
Dip-slip fault 09
Donaldson, community 4,14,30
Donaldson Lake 16

Eastman, J. and H. 44
Elphin, community 3,9,24,28,42
Elphin Intrusion ..... 9,21,24,25,28, ... 29,33,35,37,44
Eskers 27

Faults 9,33,44,49,50
  Contact 33
  Dip-slip 9
  System 33
  Zone 27,40,48,51
Ferguson, H.A. 42
Fergusons Mud Lake 35
Flinton Group 30,51
  Metaconglomerate 26,31,44,51
    Photo 24
Folds 9
Foliation 9,11-13,18-20,22,30,32,37
Frontenac Axis 9,28,30

Gabbro:
  Photo 18
  Thin section 21, 22

Garnet 10,12,17
Gemmills Hill 17,32
Geochemical surveys 41
Geological mapping 47,50
Geological survey 41,49
Gibsons Lake 14,47
Gneiss:
  Thin section 10,12
Gold 36,41,51
Gordons Hill 14,27
Grange Mining Corporation Ltd. 47
Granite sills 25
Granite veins 24
Graphite 13,14
Gravel 27
  Production 36
Grenville Province 30
Grenville Supergroup 6
Ground radiometric survey 48
Groundstar Resources Ltd. 5,41
Harvey, W. 44

Hastings Basin 30
Hematite 18,36

Iron 4
Iron ore 51
Iron oxide minerals 11,13,16-18,20-22,25
Isoclines, photo 31

Joints 10,33

Kaladar-Dalhousie Trough 4,6
Kingston and Pembroke Mining Co. 42
Kingston to Pembroke railway 36

Lavant Gabbro Complex .... 5,9,10,14,15, ... 18-20,24-26,28,29, ... 32,33,35-37,42,44,51
Leucoxene 18
Little Antoine Creek 16

Magnetite ..... 10,11,14,19,29, ... 35-37,40,42,44,48
  Deposit 43
Magnetometer 45,47
Malachite 36,42
Marble 11-14,21,27,30,32,35,37
  Horizon 20,22
  Photo 15
  Thin section 14
Marlhill Mines Ltd. 5,36,40
Marlhill quarry 37
Mary Mine 36,42
McDonalds Corners, community 11,14,41
Metamorphism 9,32
  Contact 28, 29,50
  Regional 9,10,28,29,51
  Thermal 9,33
Metasandstone, thin section 12
Metasomatism 13,16,17,37
Millers Lake 4,47,48
Minnesota Huron Iron Company Ltd. 4
Minnesota-Huron Mining Co. 44
Mississippi Mines Ltd. 44
Mississippi Mining Co. Ltd., The 42
Mississippi River 3,5
Mississippi Station, community 10,33
Mudstone, thin section 13

Niobium 25
Noranda Explorations Ltd. 45
Northbrook Batholith ..... 4,6,15,17,22,26, ... 28,30,31,33,35-37,40 44,45,47,51

Ophitic texture, photo 19
Ore zone 42
  High grade 50
  Iron 44
Otter Lake 16,36,45,47

Pauls Creek 27
Pegmatite . 9,12,14,16,23,37,40,44,48,50
  Analyses 45,47
  Assays 47
  Dikes 9,24,33,37,40,48,51
  Sills 9,24,36,37,40,44,47,48,51
Picamine Copper Gold Mines Ltd. 4,41
Picamine Prospecting Syndicate 41
Pit 36,37,41,42,48,49
Poe Mining Co. 42
Post-Flinton Deformation 30
Pratt Corners, locality 22
Properties and Occurrences, table 38
Pyrite 10,12-14,22,33,36,37,41,42,44
Pyrrhotite 10,37

Quarry 48
Quartz veins 33,36,41,42,51

Quebec Metallurgical Industries Ltd. 41

Radioactive anomalies 37,45,48
Radioactive pegmatites 40
Radioactive zones 40,45,47,48
Radiometric surveys 45
Ram Petroleums Ltd. 5,15,37,40,41
  Oil Reserves table 50
Regional metamorphism ... 9,10,28,29,51
Reid, E. 48
Repac Ltd. 49
Riddell, D.W. 41,44,48
Riddell, T. 41
Robertson Lake Shear Zone 4,6,9-14,17, ... 20,22,27-30,32,33,42
Robertsville, community ..... 4,5,9,33, ... 35-37,40-42,44,48
Robertsville (Mississippi) Mine 4,36
  Figure 43

Sand 27
  Production 36
Sandstone, thin section 13
Schist:
  Talc 50
  Talc-tremolite 48,50
    Analysis, table 49
  Thin section 12,13
Schwendiman, F.W. 42
Scintillometer survey 45,48
Serpentine 20,29
Shear zone:
  Robertson Lake ..... 4,6,9-14,17,20,22, ... 27-30,32,33,37,42,51
Sills 26,40,45
  Granite 25
  Pegmatite ..... 9,24,25,34,36,37, ... 40,44,47,48,51
Silver 41
Skarn, actinolite 49,50
Skarns 14
Snow Road Station, community 17,22,41,48
Spectrographic analyses 42
Sphene 10-13,16,18,21-23,25
Structural deformation 13,51
Sulphide minerals . 11,13,21,22,25,36,51
    see also: Chalcopyrite, Pyrite, Pyrrhotite
Supracrustal rocks ... 6,9,10,12,14-18,20, ... 22,25,26,28,30-33,44,47,49
  Mineral assemblages, table 29

Surveys:
  Geochemical 41
  Geological 41
  Ground radiometric 48
  Magnetometer 45,47
  Radiometric 45,47
  Scintillometer 45,48
Synclines 49
Synforms 15,31,40,44,50

Talc 48
  Schist 50
  Tremolite schist 48
Test:
  Pits 41,42
  Samples 42,48
  Trenches 41
Tests 48
Thermal metamorphism 33
Thin section 17-22,25
  Clastic metasediments 12
  Diorite 21, 22
  Gabbro 21, 22
  Gneiss 10,12
  Marble 14
  Metasandstone 12
  Mudstone 13
  Sandstone 13
  Schist 12,13,48
Thompson Research Associates Ltd. 49
Thorium 25,45
Titanium 44
Tremolite 13,14,51
  Ore 40
  Zone 40
Tremolite/asphalt mix 49
Tremolite-talc 05
  Horizon 14, 15
  Production 36
  Schist 50
  Thin section 48
  Zone 50
Trenching 47,48
Trent River Iron Ltd. 44

Uraniferous pegmatite 40
Uranium 5,25,36
  Mineralization 44,45,47,48,51

Vanadium 44
Veins 21,42,48
  Granite 24
  Quartz 33,36,41,42,51

Warren Bithulic Ltd. 49
Wilson Hill 24

MAPS
NOT
FILMED

CARTES
OMISES